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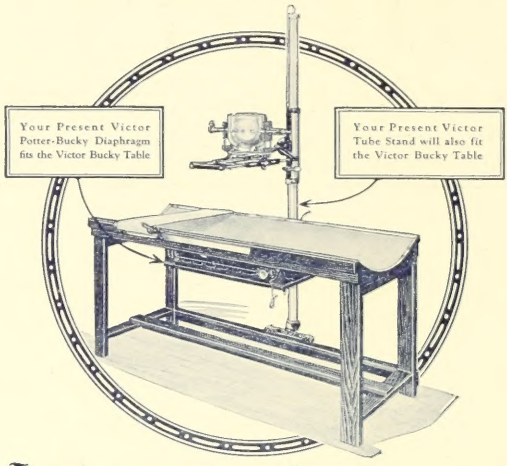
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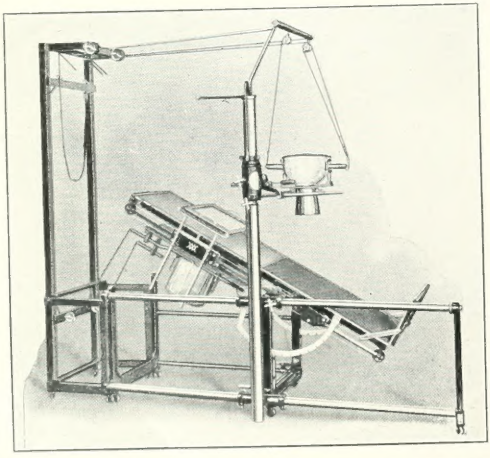

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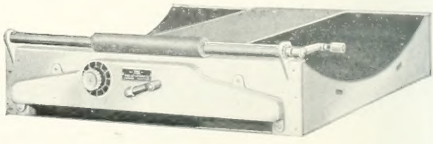

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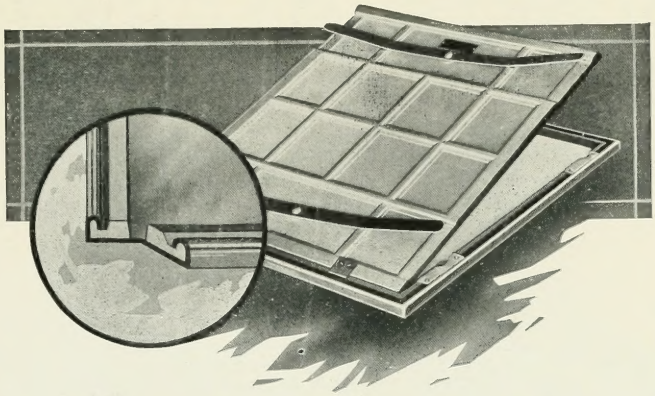

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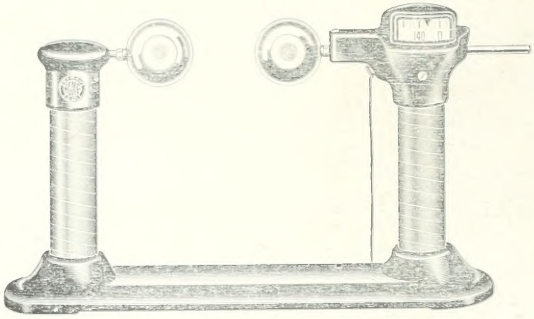

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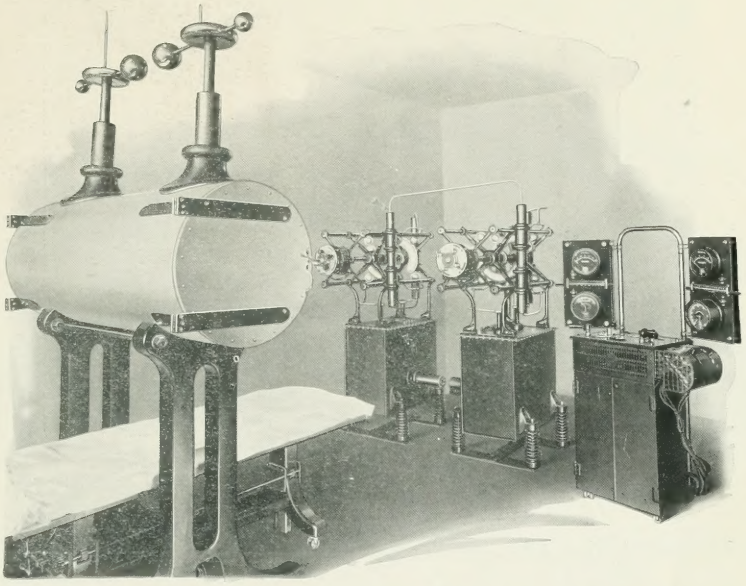

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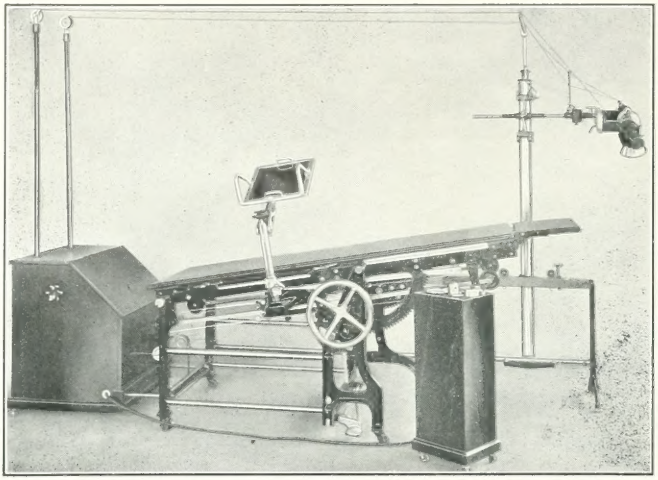

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Cancer of the Lip Treated by Radiation or Combined With Electro-Coagulation and Surgical Procedures*

GEORGE E. PFAHLER, M. D.
Philadelphia, Pa.

DURING the war approximately 80,000 American soldiers lost their lives. During the same period approximately 180.000, or more than twice as many, people in the United States lost their lives from cancer. Cancer causes one out of every ten deaths after the age of forty in this country. Cancer appears to be on the increase in every civilized country. The death rate in the United States registration area increased from 63 per 100,000 population in 1900 to 81.6 in 1917. It was estimated by the American Society for the Control of Cancer that there would be approximately 100,000 deaths from cancer in 1919. With 100,000 people dying each year from cancer, it behooves us as physicians to use every possible means to reduce this death rate, and each and every method of treatment which has been proven efficient should be used, whether singly or combined.

A cancer death is, it seems to me, the most horrible of all deaths. It involves pain, often foul odors and discharge, often marked disfigurement, and always exhaustion of the patient and distress of friends. Death from cancer of the lip involves all of these disagreeable features. Of course, at the time of death, the cancer is no longer confined to the lip, but involves the face, throat and often the chest.

Prophylactic and Early Treatment

In these latest stages, neither radiation nor any combination of treatment known today, can be expected to cure the patient. Therefore, to cure cancer of the lip, or any other form of cancer, it should be treated early and thoroughly. Thorough treatment of cancer of the lip must include radiation, no matter what other form of treatment may be used in combination. I believe that the patient having cancer of the lip does not get all possible chances for recovery unless radiation is given. Whether radiation should be used alone or combined with other treatment is a matter for careful judgment in the individual case.

Every form of irritation affecting the lip should be removed, such as irritation from a pipe, cigarette paper, excessive cigar smoking, traumatism, irritation from a jagged tooth, or excessive exposure to heat, cold and wind.

Any fissure or crust formation on the lip that lasts over four weeks without complete healing should be looked upon with suspicion. If patients are thoroughly treated in these early stages, practically all should get well.

The General Practitioner and the Patient

As a rule the general practitioner is the first to see the patient. His advice and his treatment is likely to be the deciding factor between success and failure. He should not apply superficial caustics or irritants such as nitrate of silver. I believe that repeated applications of nitrate of silver stimulate the growth of cancer about the mouth. If in doubt as to the diagnosis or treatment, the general practitioner should consult with one who has had a greater experience in this special field. Such consultation today is always available, without regard to the financial condition of the patient. Very frequently the patient will avoid seeing any physician, because he fears that he will have to be operated upon, and for this reason he does nothing, or applies home remedies, drug store applications, or more frequently goes to a cancer quack who is likely to apply some caustic paste. It is this latter group of failures and delayed cases that make up the most distressing group any of us are called upon to treat. They come late, perhaps only for the treatment of the metastases, and because surgery or radiology fails in this group both methods are condemned by the patient and his friends; and his friends, like himself, are likely in their turn to lose the best chances for recovery.

If, however, we let it be known that local application of radiation, thoroughly done, or local destruction of the diseased area by electro-coagulation followed immediately by thorough radiation of the adjacent tissues and especially the lymphatic areas, is likely to cure this lesion, and without much pain or interruption of work, the patient will be likely to consult the physician early.

This fact, however, increases greatly the moral responsibility of the radiologist, the general practitioner or the surgeon who undertakes this work. We should realize our limitations. Our motto should be thoroughness.

Diagnosis

Any crust, fissure, or new growth on the lip that lasts over a month is at least potentially cancer. A careful taking of the history, and a study of the patient's habits, together with careful inspection and palpation will generally enable one to make the diagnosis. In this connection the possibility of a primary luetic lesion must be considered but a Wassermann test or consultation with a competent dermatologist or syphilologist will help to eliminate lues from the diagnosis. One must not permit the mere presence of a positive Wassermann test to eliminate the diagnosis of cancer. I have seen many failures in cancer about the mouth due to a prolonged course of treatment for syphilis, and neglect of cancer treatment. The local lesion in these cases is probably engrafted upon a syphilitic base. We must remember that a patient can have both syphilis and cancer at the same time. I believe that the removal of a section is inadvisable unless the disease is immediately destroyed and radical treatment given. Bloodgood [1] has well stated that the removal of sections for diagnosis followed by delaying the radical treatment only aggravates the disease and gives no advantage. If excision is to be done it must surround the disease or failure will result.

*—Read before the Joint Meeting of the American Radiological Society and the Chicago Medical Society, December 7, 1921.

Results of Treatment

I will only review the cases treated in my private clinic, because of the difficulties in tracing patients in the hospital clinics. Many patients have been treated in the x-ray departments of the hospitals. Most of these were postoperative or recurrent cases, and in many instances they did not consider themselves our patients. They looked upon the postoperative treatment as an unnecessary annoyance, and often prematurely discontinued treatment. The recurrent cases were generally far advanced, usually hopeless, and were referred to the department because there was nothing else to do.

The early cases will, of course, give the best results, and if treated thoroughly all should get well. Our records do not show that all do get well, but in the cases in which we failed the patients were difficult to manage. One had an associated luetic infection and developed an extension in the cheek and jaw after seven years. During this stage he died of pneumonia. It remains doubtful whether this induration about the angle of the jaw, but above the lower edge of the bone, was luetic or malignant, since we were not permitted to remove a section for microscopical examination. Another patient never returned after the first treatment. The third failure, I believe, was due to insufficient treatment at the very beginning. While there was no local recurrence, an indurated ridge developed at the inner border of the original lesion and extended downward and outward toward the right submaxillary gland. The side of the cheek from the angle of the mouth to the submaxillary gland became indurated and undoubtedly malignant. The patient became discouraged, but at the time of the last visit the submaxillary gland was not palpable. It would seem that the treatment given to the submaxillary region was efficacious.

In another case, eighteen months after the primary lesion had disappeared, a metastatic lymph node developed in the submaxillary region. In looking about for the cause of this surprise we found that through some mistake in the office the patient had *not* received treatment over these glandular areas. While it is unfortunate for the man, it illustrates beautifully the importance of thorough treatment of the lymphatic regions by radiation, either with the roentgen rays or radium at the beginning, and subsequently sufficient treatment to insure thorough destruction of the cancer cells. This recurrent lymph node is now being treated, apparently with success, by the insertion of radium needles.

In my private clinic we have treated ninety-six cases of cancer of the lip; primary seventy-two, recurrent twenty, postoperative five. Out of seventy-two primary cases from my private records sixty-five recovered and have remained well from several months to eighteen years. Two have died of a continuation of the disease, two have a recurrence and in two the result is unknown.

I realize that such a record is not beyond criticism, because the duration of the results is variable, and other failures may have to be recorded. However, since the results obtained by my colleagues, Henry K. Pancoast and Wm. L. Clark, correspond so closely to my own, and were obtained by similar technique, and since the results in the older cases are most satisfactory, I am led to believe that our enthusiasm is justified and that this method of treatment can be recommended.

The recurrent cases are always more difficult. Of the twenty recurrent cases treated, only eight recovered. Much will depend upon the promptness and thoroughness with which these recurrent cases are treated, but in part, at least, the results will depend upon the nature of the cancer or the degree of malignancy. One must obtain prompt results from radiation or failure is likely to result. Thorough radiation by the roentgen rays, and by radium when it can be combined to advantage, from the very beginning is most important. I never like to have a patient referred to me after some one has used insufficient radiation over a considerable period of time, and (recognizing failure) has concluded that perhaps more thorough radiation might produce good results. In such cases, unless the disease is so situated that it can be destroyed by electro-coagulation, failure will be the rule.

The five patients given postoperative treatment have remained well, though in none was there a block dissection.

Technique

In the treatment of malignant disease, probably more than in any other field, skill and keen judgment is required. One must understand the nature of the disease and its lines of distribution. One must then use enough radiation to destroy the cancer cells and at the same time do as little damage to healthy tissues as is possible. Boggs [2] says: "Too many failures have been accredited to radium, when as a matter of fact, through inexperience and lack of proper study, only partial doses were given." We must realize that the mere possession of a quantity of radium does not make a radiologist any more than the possession of a few surgical instruments makes a surgeon. The surgeon needs not only a thorough equipment of instruments, but knowledge, keen judgment, and skill; so, too, the radiologist needs a good equipment, a knowledge of the disease he is treating, and skill in the application of the radiation.

Electro-Coagulation

Electro-coagulation consists in the coagulation of the diseased areas by means of the heat produced by the high frequency current as it passes through the body from a point attached either to the Oudin current or to one pole of the d'Arsonval current. The Oudin current (unipolar) is used for small lesions, and the d'Arsonval current is used for the larger lesions. If the d'Arsonval current is used one pole is attached to a pad or smooth metal

Figure I.—(a)—Dr. J. E. Bowman's patient. Epithelioma of the right side of the lower lip. Followed a cut with a razor two years previously. Had been treated previously with silver nitrate. No palpable glands. Destroyed by electro-coagulation February 27, 1915.
Figure I.—(b)—Healed and apparently well April 9, 1915. Still well April 14, 1921, after six years.

electrode placed under the buttocks of the patient, while the active electrode is a point. This current is not selective in its action, but will destroy the tissues radiating outward from the point. One cannot use this current, therefore, in locations in which essential structures, such as important blood vessels or nerves, are located in the line of destruction. There will be a zone beyond the actual coagulation which will be superheated and will be sufficient to destroy cancer cells, but will not destroy the healthy tissue. In this way one conserves tissue, and as is shown by my own cases and those shown by Clark [5] the defect, after the patient is well, does not nearly equal the amount of disease removed. There is, apparently, a regeneration of a part of the tissue removed. The heat is generated in the tissues. It is the penetrative value of this form of heat that makes it more desirable than that obtained by the thermocautery, which destroys only by transmitted heat, and, therefore, is essentially more superficial. The destructive value of the current used can only be learned by experience, but much experience can be obtained by practice with a piece of liver, or other meat. Such experience from practice with a piece of liver cannot be directly transferred, for the current value will vary with the shape of the lesion to be destroyed, whether small and prominent, such as a wart or mole, or flat and indefinitely outlined, such as carcinoma. The current value will also vary with the size of the mass or body to which the tissue to be destroyed is attached. The milliammeter is not of great value in judging the effects.

The tissue as it is destroyed by the high frequency current turns white, if it is coagulated, or if small, is dried up and sparked through the air. (Desiccation).

Selection of cases suitable for electro-coagulation is necessary. If the lesion is small, and its removal will not cause too serious a defect in the lip, I believe that such destruction will be followed by more prompt and more satisfactory results than by radiation alone. By such destruction we remove the macroscopical disease just as the surgeon does with the knife, but we do it without opening any blood vessels or lymph channels. If the lesion is fairly large I trim the destroyed tissue away with curved scissors, always carefully cutting within the destroyed area. In this way one eliminates part of the disagreeable odor which accompanies the sloughing process.

If the cancer involves the entire lip, or even half of the lip, such preliminary destruction by electro-coagulation is impractical unless one can foresee some means of closing the mouth by a subsequent plastic operation. If such a subsequent plastic operation is planned the surgeon who is to do the operation should see the patient and be consulted in advance, before the radiologist attempts the destruction. We have no more right to assume in advance what the surgeon's judgment and procedure will be than the surgeon has a right to assume what will be the judgment and procedure of the radiologist. Both specialties are developing too rapidly for either to take up the other as a side issue, and more will be accomplished by co-operation.

Generally speaking, I believe that in these advanced primary cases a thorough trial should be made first with applications of *radium*, and if skilfully applied, good results may be expected. In some cases marked temporary improvement only may occur, and a stage is then reached in which the disease is at a standstill or may begin to progress in spite of radiation. At such stage, complete and thorough local destruction or complete surgical excision is probably the only procedure left. With the co-operation of skilful surgeons I have had success in some such advanced cases.

Radiation

Radiation is indicated in all cancers of the lip, no matter what other treatment is used, and sufficient radiation must be used to actually destroy the cancer cells. If a patient is to be operated upon surgically, a preliminary radiation with a full erythema dose should be given over the lip and chin, and in the submental and submaxillary regions. After the operation, in two to three weeks after the preliminary treatment, similar radiation should be given. The patient should then be kept under observation for several years, and more radiation should be applied if there is the slightest sign of recurrence. This same sort of radiation should be added to electro-coagulation, and can be applied most practically by means of the roentgen rays. For this purpose I use a nine inch spark gap, with five milliamperes of current, through six mm. of aluminum filter, at a distance of thirty cm. for twenty-five minutes. The time must be governed by the radiation value of the individual instrument used.

If one possesses sufficient radium and sufficient skill in its use, most and perhaps all, local cancers of the lip can be cured by this means. It will require more time, more skill, more patience than by the combination of electro-coagulation and radiation, but there will be more preservation of tissue and a better cosmetic result than can be obtained by any combination with surgery or electro-coagulation. Therefore, I can lay down no rule for the treatment of all cases. The circumstances surrounding the individual case should govern our procedure. Quick was successful in 69.5 per cent with local applications of radium to the primary tumor.

If radium is to be used for the local destruction of the cancer with the preservation of the tissue the local tissues must be kept saturated to the limit of toleration of the normal structures until the cancer entirely disappears.

If one has sufficient radium the submaxillary regions can be treated by surface applications, properly screened,

Figure II.—(a)—Dr. W. J. Dubler's patient. Epithelioma of the lower lip following "fever blister" three years previously. No palpable lymph nodes. Destroyed by electro-coagulation July 15, 1915.
Figure II.—(b)—Healed and apparently well October 27, 1915. Still well November, 1921. Defect not noticeable when mouth is closed.

otherwise the roentgen rays should be used.

If metastatic nodules are palpable they should have preliminary radiation, as above described, and should then be dissected out surgically, or treated by the insertion of radium needles sufficient to destroy the disease.

Radium needles of ten mg. each may be inserted one cm. apart throughout the diseased area, and left in place for eight hours. Following the insertion of radium needles into tissues there is the production of fibrous nodules (especially when the needles are placed farther apart, and left in place sixteen hours), which are composed of fibrous tissue and result from the necroses produced by the radium. They will lead the untrained to suspect malignant nodules or redevelopment of the disease. With our meager knowledge on this point, it will require considerable skill to be able to distinguish between the disease and the fibrous tissue. Therefore, I urge close observation, lest a false security may lead one to neglect true malignant disease.

The following conclusions may be drawn:

1. Any fissure or crust on the lip which lasts over a month should lead one to suspect malignancy.

2. Local destruction by electrocoagulation, followed by thorough radiation should cure practically all cases if treated early.

3. Thorough radiation by radium or the roentgen rays should be given over the lymphatics draining the diseased area.

4. Recurrent carcinoma gives very much less satisfactory results.

5. Metastatic lymph nodes should be treated by surface radiation and then by radium implantation or by excision.

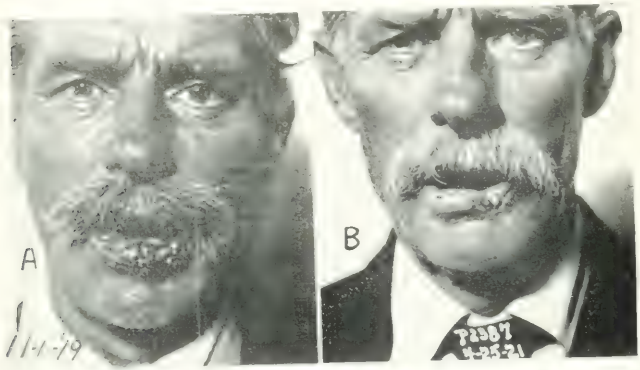

Figure III.—(a)—Dr. Chas. Cunningham's patient. Epithelioma of the entire lower lip. Followed an injury by the limb of a tree five years previously. No lymph nodes palpable. Treated by radium because destruction would have involved the loss of the entire lower lip.
Figure III.—(b)—Treated last on February 3, 1920. Still well November, 1921.

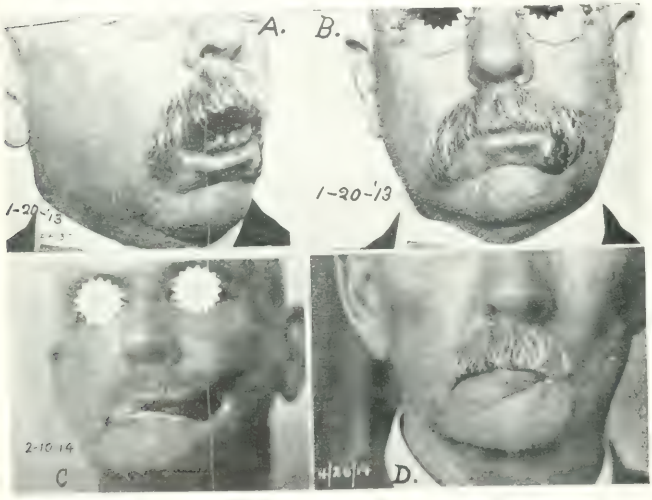

Figure IV.—(a) and (b)—Drs. Deemer and Dachtler's patient. Duration twelve years. Had been treated previously by the x-rays. Epithelioma involved two-thirds of the lower lip, one-third of the upper lip, the inside of the cheek to the angle of the jaw. No palpable lymph nodes, probably because of the previous radiation treatment. Destroyed by electro-coagulation, January 20, 1913 with application of radium inside the mouth and x-ray treatment over the wound and submaxillary region.
Figure IV.—(c)—Showing wound healed after extensive electro-coagulation. Defect was then about one-half of what it was at the time of the destruction.
Figure IV.—(d)—April 20, 1914, after closure of the mouth by Dr. Laplace. Still well May 3, 1921, and probably today, eight years after combined treatments.

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DISCUSSION

DR. WILLIAM ALLEN PUSEY *(Chicago)*: There is not a great deal for me to say, except to express my appreciation of this very excellent paper. In nearly all particulars my experience agrees with Dr. Pfahler's and I can corroborate the views that he has expressed.

In regard to the diagnosis, the importance of early diagnosis in these cases cannot be too much emphasized.

There is one point I do not agree with, and that is the proposition that it is dangerous to take sections from these epitheliomas because of the likelihood of causing more rapid spread of the disease. That has been a bogey with us for a great many years.

Personally, I am thoroughly ready to say that ninety per cent, certainly, of carcinomas of the skin can be as accurately diagnosed by the eye as they can by the help of the eye and microscope. I do not believe we should hesitate to take sections where we please.

I was greatly gratified a few months ago to read of experimental verification of that view. I have forgotten just whose it was, it may have been Dr. Francis Carter Wood's. I believe he is here and he can correct me if it was not. One of the most reliable men

working in cancer research made a number of experiments on this subject with a large number of controls. He found no more rapid spread in animals from which sections had been taken than he did in the control animals. I would like to call attention to that point and say that my experience does not uphold the view that we should hesitate to take sections from these cases when we please.

As to the treatment of epithelioma of the lip, I believe when you approach that territory you are approaching one of the most dangerous ones for radiotherapy to attack. Personally, I approached it with great trepidation. In my early days in the use of x-ray I formulated the rule that I was willing to treat epitheliomas with x-ray if they were such that a conservative surgeon would not think it necessary to remove contiguous glands. At that time the doctrine was almost universal that epithelioma of the lip meant removal of the glands beneath the jaw. I think my courage to attack epithelioma of the lip was first developed by the fact that some very good surgeons brought members of their families to me to have small epitheliomas of the lip treated with x-ray. I vividly recall a distinguished surgeon bringing his father to me. I thought that was a good precedent. I began to treat superficial epitheliomas of the lip with x-ray and I have done so ever since.

The first thing it established was, to my mind, that there are many epitheliomas of the lip in which the involvement of the associated glands is relatively slow to occur. I do not know how many epitheliomas of the lip I have treated. As I remember, about ten or twelve years ago when I looked over those cases, it was over one hundred. I am sure I have treated several hundred cases of epithelioma of the lip with x-ray. I am not in a position to give the statistics tonight, but my conscience does not hurt me for treating those cases. I feel they have given as good results as could be gotten other ways.

My treatment of epithelioma of the lip has been controlled by a careful selection when I come to deal with operative cases. I prefer to send deep nodular epitheliomas to the surgeon for operation and I want to keep for x-ray treatment only the superficial lesions, I care not how extensive they are.

I have treated many rather deep nodular masses of carcinoma of the lip with x-ray, but in my judgment those cases should have some other form of treatment first—should have radical destruction as far as possible first. Whether this is to be done by electro-coagulation, surgery, or some other method of destruction is a moot point. I feel it does not make much difference how carcinoma is destroyed so long as it is destroyed. When it comes to electro-coagulation, I am not convinced that it is a method of preference in treating the lip. It seems to me that in extensive cases of lip carcinoma, where the work can be done so thoroughly by operation, that operation may put up strong claims.

I have seen Dr. Clark's work and the work of the essayist this evening in extensive inoperable carcinomas about the mouth. It seems to me that some of their results are marvelous. I believe electro-coagulation has a large field there. In this particular group of cases here, however, I am not convinced that it is more useful than older procedures.

As to the prophylactic use of x-rays, I have never felt inclined to use x-rays preliminary to operation when operation was feasible at the time. I have used x-rays before operation and I can not strongly advocate the preoperative use of x-rays. It seems there is no particular reason for it if you operate quickly, soon afterwards, and that the postoperative treatment covers the ground. I have used postoperative x-ray treatment for carcinoma for over twenty years for a good many of the surgeons. I believe experience thoroughly justifies the procedure.

I believe it applies to the neck and lip as well as to carcinomas of the breast and other carcinomas that can be reached. With these very minor exceptions, I quite agree with the paper and congratulate the author. (Applause).

DR. EMIL G. BECK *(Chicago)*: I suppose that I am expected to discuss this from the standpoint of surgery. Surgery in this class of cases alone would be insufficient. In the face of these illustrations here, I do not see how any body can doubt the value of radium and x-ray in connection with surgery in cases of cancer of the lip.

In a recent meeting in Chicago on the cancer problem where Dr. Maud Slye showed some of her work and I had the chance to show some cases treated by surgery, especially those of the jaw and lip, she made the statement that if she had cancer she would not come to see me. I asked why and she replied that she was afraid I would cure her. The only objection that could be used against these cases is the deformity. Cancer patients do not care if only they live.

In discussing the subject from the practical standpoint of surgery, I will say, as does Dr. Pusey, that it makes very little difference how you destroy the cancer if you follow it up with radiotherapy in order to prevent the recurrence in parts which cannot be reached by the surgeon.

I have no experience, of course, in the coagulation method. I have treated all of my cases with surgery first, leaving the wound open.

DR. C. W. HANFORD: There is a practice common among our leaders, that is the use of an escharotic before

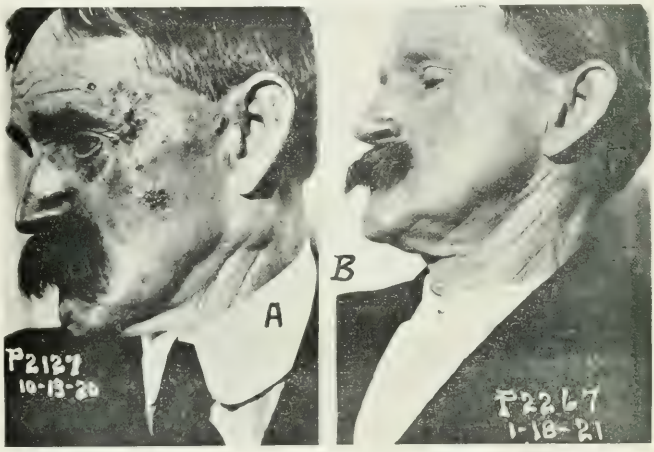

Figure V.—(a)—Dr. Harry Jarrett's patient. Epitheliomata in the left temporal region and sides of the face with metastasis from the temporal lesion back of the angle of the jaw. Lesions on the face destroyed by electro-coagulation October 13, 1920, followed by x-ray treatment and eight ten-milligram needles inserted into the metastatic lymph node for five hours, October 12, 1920, and for six and one-half hours November 23, 1921. Figure V.—(b)—Shows complete disappearance of this lymph node January, 18, 1921, together with disappearance of the other lesions on the face. There had been no recurrence of this lymph node November 14, 1921.

the patient is sent to a surgeon or roentgenologist or radium therapeutist. They have so many times attempted to use silver or a little paste with a little carbon dioxide, until finally, when the patient comes before the roentgenologist the tissue is so devitalized that it is a question whether we want to do anything or not. I think we should be as chary against the use of these escharotics in the case of epitheliomas as we would be of a rattlesnake.

As regards the nose, we find that the needles placed in the nose seem to answer all requirements. We find four to five hundred milligram hours in a nose the size of a small English walnut is sufficient to cause cryptic change. If you take that out you will find no carcinoma.

There is another point I want to speak of and that is cleanliness. It is a foul habit for the patient to be continually licking the tongue after radiation. He may undo many efforts there. It is my practice to have them wear continually a piece of gauze or several thicknesses saturated in boric acid solution and these are changed every hour. For the mouth particularly they should carry a package of gauze and change this every hour. Better results will come if that cleanliness is observed. At the Cook County Hospital we are trying out diathermals. We hope to get our technique to the point where we can prepare a surface for radium and get results in cases that now go down to the grave. (Applause).

DR. C. M. MCKENNA: What anesthesia, if any, do you use? It seems that Dr. Pfahler brought out an important point when he said he could tell how much destruction would take place by using the radium. It seems to me that he further brought out a point that the man doing that work should do it alone and it could not be used as a side issue.

While I am not doing lip surgery, I have had chances to see bladder cases where we used radium and had a considerable amount of contraction afterwards, due to the destruction in the bladder outside the diseased part. That is an important point and one that a man using radium or x-ray should know.

DR. PFAHLER: I would like to thank the gentlemen very much for their discussion. First, Dr. Pusey's criticism about the removal of a section. It requires very little more traumatism or deformity to destroy the growth and if it were on my lip I would rather have it off than merely know what it is. (Applause).

Now, with regard to the ante-operative treatment, If I were to limit my treatment to one of two applications, either one immediately before or one immediately after, I would want the treatment immediately before, because by this means we devitalize those carcinoma cells so they have less power of being transplanted into the open wound. That is not guess work—it has been worked out scientifically and experimentally.

I have not the names in my mind at the present time, but, for instance, one of the experiments that was carried out along this line consisted in taking a series of mice with rat sarcoma. That gave a definite and uniform order of reproduction. A tumor was treated, then half of the tumor was taken out and inoculated into some other rats. The other half was treated by the rays *in situ*. It was taken out, inoculated into a corresponding group of rats. The second sarcoma did not have any takes. You will find that work reported by Colwell and Russ. There is a great deal of work being done along this line. I consider the ante-operative treatment the most important.

With regard to anesthesia, if the lesion is small, such as the group we like to get, I inject the lower lip with novocain, keeping the point of injection well beyond the diseased area and destroy it by means of electric coagulation. I have had no bad results of any kind. If it is a large case, that is, a case with large lesions, general ether anesthesia must be used. If you use ether you must be very careful to remove your ether completely from the patient before you attempt to do this destruction or you will have an explosion.

Duodenal Bulb Deformity in Relation to Symptoms and the Chemistry of the Gastric Juice*

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DUODENAL bulb deformity outranks every other x-ray sign of duodenal ulcer. The serial method which the genius of Lewis Gregory Cole has brought into universal recognition makes the demonstration of this sign more certain than surgical exploration. It is acknowledged that bulb deformity may have other causes than duodenal ulcer and that duodenal ulcer may be present in a bulb of normal contour, but in actual practice it is apparent that the roentgen diagnosis of duodenal ulcer hangs upon this single sign.

The accessory roentgen signs of duodenal ulcer are relatively indecisive. The rapid expulsion of the barium meal may be taken to substantiate the bulb deformity, or, again, a six hour residue may be interpreted to do the same service. A type and tone of gastric peristalsis may be called characteristic, but again in certain cases a gastrospasm is equally convincing. The localization of a pressure-pain in the bulbar region ignores the gall-bladder on one side and the head of the pancreas on the other. Moreover, an epigastric pressure-pain may not uncommonly be elicited without a pathologic basis of any kind. In short, the bulb deformity is seen to stand back of every other roentgen sign of this disease.

Notwithstanding the dominance of this sign it is not alone a sufficient basis for a diagnosis. Adhesions and reflex spasm from neighborhood diseases are rare but demonstrated causes of persistent bulb distortion. The greatest error comes in borderline deformities, where the bulb is not normal and yet not definitely deformed; often it is either too small or conspicuously large or again it shows a diverticulum, which may be either congenital or a result of ulcer. Not all cases are clear cut and convincing. It is desirable, therefore, to have some diagnostic support from quite a different source.

Such support stands ready in the history of the case and the chemistry of the gastric juice. It will be objected at once that this is the province of the internist, not of the roentgenologist. It is my cherished conviction that the roentgenologist who voluntarily cuts himself off from the history of the case, the physical examination and the laboratory findings, sacrifices the professional status with which his medical education endows him and instead of assuming the standing of a consultant, rates himself as a technician. It is his right and privilege to ask for the clinical records in order to make better and wider interpretations of his roentgen findings. In all cases of suspected duodenal ulcer, whether or not there is a

*—Read at the Annual Meeting of The Radiological Society of North America, Chicago, Dec. 7, 1921.

distinctive and persistent bulb deformity, he should carefully consider the symptoms and the chemistry of the gastric juice before translating his roentgen findings into the terms of a clinical diagnosis.

I am but repeating and emphasizing what many other workers advocate. Carman in his "Roentgen Diagnosis of Diseases of the Alimentary Canal" gives one of the best resumes of the symptoms of duodenal ulcer that can be found. He also provides a place on his roentgen record sheets for the examination of the stomach contents. Holzknecht included the hydrochloric acid percentage in his symptom complexes, where the signs and symptoms were cut to the irreducible minimum.

In order to examine the value of such methods I have reviewed a portion of our own work of the last five years. During this time the stomach contents have been examined in our laboratory in approximately one thousand cases which have made complaints of digestive symptoms of some kind. This number is of course small in comparison with cases passing through great hospitals and clinics. Their chief value lies in the care and completeness with which each case has been examined. The work has been carried out as a part of daily practice in conjunction with my associate, Doctor, John B. Jackson, and the help of several very capable assistants. The records include the history, the physical examination, the x-ray examination and the laboratory analysis of the blood, urine, stomach contents and such other material as may be obtained.

The general percentages represent, we believe, a fair average of cases as they occur in towns under fifty thousand surrounded by an agricultural population. Statistics at best are but approximations. City hospitals represent various grades of unavoidable selections. Sanitoria attract the wealthy. Charity or county hospitals receive cases that have been subjected to the influences of poverty, ignorance, filth and neglect. The statistics given in this paper represent a cross section of the average American population living under fairly favorable conditions outside of large cities.

In most cases the stomach contents have been obtained by the Rehfuss method. Five or six samples are taken at fifteen minute intervals during the process of digestion, beginning one-half hour after the Ewald test meal. This fractional method, with a varying acidity in each sample, makes possible a comparison of cases by means of the acid curves.

Four types of curves are seen: first, a regular half-moon form with the height of the acid curve in the middle sample; second, an ascending curve with the height in the final sample; third, a descending curve with a high initial acidity; fourth, a sustained curve with a high initial acidity, which is maintained throughout digestion. These curves bear a closer relationship to symptoms than to bulb deformity, but yet seem not without significance.

Of our one hundred and twenty-six cases in which duodenal ulcer was diagnosticated we constructed acid curves in ninety-four. Of these, forty-nine showed an ascending curve, twenty-four a sustained curve, sixteen a regular curve, and only five an initial hyperacidity with a descending curve. The ascending hyperacidities showed the most uniform concurrence of an ulcer symptomatology with a persistent bulb deformity. The sustained curves, however, were of no less importance, as seen by operative results. Of the twenty-five cases operated upon in this series, eight showed the sustained hyperacidity and in every one ulcer was found; also eight showed an ascending type of curve, and in three ulcer was not found. In two of these cases the duodenum was not explored because of the patient's request, only the appendix being removed. In the other case, the concurrence of a pronounced hyperacidity, a clear ulcer history and persistent deformity of the bulb made us unwilling to accept the operative findings as final. We would, therefore, look upon these two types of acid curve as of equal significance, and when existing in a case of doubtful deformity of the bulb would inclined the diagnosis in favor of ulcer.

Of the one thousand cases of gastric analyses, four hundred and thirteen showed a hyperacidity and one hundred and nineteen showed achylia, or a total absence of free hydrochloric acid. Duodenal ulcer was diagnosticated in one hundred and twenty-six, gastric ulcer in twenty-six, gastric cancer in twenty-eight, and duodenal cancer in one. Duodenal ulcer below the bulb was found twice. Duodenal ulcer was thus diagnosticated more than twice as often as all other organic diseases of the stomach and duodenum combined, but less than thirteen per cent of all cases coming in with digestive symptoms showed duodenal ulcer.

As previously stated, these cases were studied by both x-ray and clinical methods. Much attention has been paid to the taking of histories. For our medical forefathers, the history of the case was almost the sole foundation for diagnosis of peptic ulcer. The physical examination added little, often nothing, except in cases of perforation and hemorrhage. The localiation of a pressure-pain was very misleading then, as now. Moynihan's dictum was, "history everything, physical examination nothing." It is true that in no other organic disease is so brief a history so convincing. Epigastric pain relieved temporarily by eating or by an alkali is the pivotal fact. In some cases, vomiting, hematemesis, nausea, and regurgitation are to be added. Constipation is the rule. The fine art of taking histories requires correlation of isolated facts, and a keen insight, which is a mixture of temperament and experience —therefore, a history is largely an individual matter and can never be of equal value to all examiners. A history alone has irreparable shortcomings at the best. This is clearly revealed by the case records of pre-roentgen days when gastric ulcer was believed to be relatively common and duodenal ulcer exceedingly rare. The x-ray and operative findings have shown that the opposite is the truth. Granted that a history is an untrustworthy guide to the localization of ulcer, it is notwithstanding, the fundamental document of diagnosis to which laboratory analysis and the roentgen findings are but contributions.

In our records of one hundred and twenty-six cases of duodenal ulcer an ulcer symptomatology was found in all but nine cases. When these nine were studied six were found without hyperacidity. The three which had hyperacidity with bulb deformities submitted to laparotomy. One showed a general carcinomatosis, one a cancer of the liver, and one a cholecystitis with gall stones. Of the four which showed no hyperacidity, ulcer was found in two, no ulcer in one, and one remained without operation. If conclusions are allowable from such limited data, we would say that in the absence of hyperacidity symptoms may not be produced even though ulcer is present in the bulb, and that in cases with hyperacidity and with bulb deformity the absence of ulcer symptoms is strongly suggestive of some other abdominal disease.

A history suggestive of ulcer may be found occasionally in cases of achylia. In the literature many duodenal and gastric ulcers have been reported with a total lack of free hydrochloric acid. In the present series one hundred and nineteen cases of achylia are recorded. In not one were we able to make a diagnosis of ulcer and no ulcer has since been found in any one of these cases. However, twelve of our cases of duodenal ulcer showed a total lack

of hydrochloric acid in one or two samples of the five fractions of the stomach contents, but in five of these twelve cases there was a well marked hyperacidity in the final fractions, while in the seven remaining there was a final normal acidity. If a single sample had been relied upon for the gastric analysis these patients might have been rated as cases of achylia. Inasmuch as ulcers may be latent or without symptoms, usually in the absence of a hyperacidity, the presence of a history suggestive of ulcer in a case of achylila would lead us to look for other pathology than duodenal ulcer.

Gastric peristalsis in achylia is deep and vigorous and the expulsion of the barium very rapid, thus exactly simulating duodenal ulcer. Gastric analysis is therefore very important. The bulb fills especially well in a case of achylia and is as a rule large and of the typical pyramidal form. But in cases of doubtful bulbs the gastric analysis may be the decisive factor in diagnosis.

The frequency of diverticula of the duodenum in ulcer exceeded our expectations. In one hundred and twenty-six cases thirteen were found. When originating in the bulb they are difficult to distinguish from true bulbar deformities. When a positive history and hyperacidity are both present such cases must be placed in the ulcer class, although diverticulitis may be a more correct diagnosis.

Chronic appendicitis and cholecystitis, with or without gall stones, are frequent causes of mistaken diagnosis. I believe that an irritable appendix may cause an incisura of the bulb. It is well known that adhesions to the gallbladder are causes of pseudo-bulbar deformities. A good history is nowhere of greater value than in such cases.

Operation was performed on only twenty-five of the one hundred and twenty-six ulcer cases, although surgical treatment was advised in many more. The answers to follow-up letters show that the reason for this is the prompt and satisfactory recovery under the alkaline treatment as advised and practiced by Dr. Sippy. Of these twenty-five operated cases ulcer was found in nineteen. In two cases, at the request of the patient, the duodenum was not explored, but only the appendix removed. In four cases the surgeon failed to find ulcer. In justice to the roentgenologist it may be said that duodenal ulcers are often found with great difficulty, even by experienced surgeons. When the roentgenologist can attend the operation the advantage is mutual, but outside of institutions this cannot always be done.

Of the four operated cases in which ulcer was not found three showed a persistent bulb deformity. In one, however, a good ulcer history and a hyperacidity were lacking. Also one gave a good ulcer history and a hyperacidity, but showed a normal bulb. A sound diagnosis should show all three factors, namely, ulcer history, hyperacidity, and bulb deformity

In conclusion, we would urge the use of clinical records before x-ray interpretations are made, first, because that procedure minimizes errors, especially those of omission, and second, because it preserves the professional status of the roentgenologist.

Discussion

Dr. E. W. Rowe *(Lincoln Neb.)*: It may be like carrying coals to Newcastle to discuss the papers of the morning, especially since I wish to confine my remarks to the diagnosis of gastric and duodenal ulcer.

I am going to report, probably, some well known points. It is of value to re-emphasize these points because they are valuable points.

Statistics often may be twisted so they are not worth much, but nevertheless the size and importance of the field of the roentgen diagnosis of duodenal ulcer has hardly been appreciated.

A summary of fifty-nine thousand autopsies published by Dr. Easton shows gastric and duodenal ulcers incident in four per cent of these.

I want to call your attention to the increase in accuracy of diagnosis since a few years ago when twenty per cent was the accuracy of diagnosis. Today, with combined methods, it is practically one hundred per cent.

This is the point I wish to make from this: The work of the roentgenologist has not only increased the accuracy, but it has stimulated the clinician so that he also has increased his percentage of accuracy.

Little has been said about fluoroscopy versus the roentgenogram. I think fluoroscopy is not sufficient for the average worker. The roentgenogram combined with the fluoroscope is of great importance to the average man. The roentgenogram gives a series of different phases of motor activity. I wish to call your attention to the fact that we are still in the transition period of method of diagnosis. There are still some who are plotting beautiful curves that only a physiologist can understand and they are making accurate deductions from those curves. In the hands of a man like Dr. Sippy, such a method may be of high value. In the hands of Dr. Carman, x-ray alone shows a value of almost ninety-eight per cent, but for the average man, these methods must be combined or the per cent will not be nearly so high.

I wish to call your attention to the fact that the negative diagnosis of gastric and duodenal ulcer is of vast importance. Exploratory operation is often permissible, is often right, but exploratory operation tends to be used less and less as accuracy of diagnosis increases; when exploratory operation is done, it is simply a frank, usually an honest, admission of inaccuracy or fallibility of diagnosis.

Every gastric or duodenal ulcer known to exist should be studied at least once a year, not to determine whether it is present especially, but to determine the condition of the type of ulcer, for upon the diagnosis or the determination of the type of ulcer depends the method of procedure.

In the diagnosis of all troubles in which there is more than one valuable diagnostic point, we must keep in mind the relative importance of these points. Too often we are lost, not being able to keep in mind the relative value of points. I am reminded of a homely expression of Dr. Mayo, which I have heard him repeat a number of times, namely, that there are ten dollar bills in diagnosis and there are five cent pieces in diagnosis. Of course, the ten dollar bill in diagnosis of duodenal ulcer is the deformity. There are many points which might be called five cent pieces. (Applause).

Dr. Milton M. Portis *(Chicago)*: It is possible to touch only briefly upon the points of these very excellent papers to which it has been my privilege to listen this morning.

Dr. Crane, in his usual characteristic, clear way has brought home to you again the fact that medicine covers all fields. None of us is an entity. We must work together in harmony and must give to the patient our combined advice.

It is the atypical case that Dr. Crane is talking of. Dr. Carman showed you an error of five per cent in his work. We are not yet at the stage where we can make one hundred per cent diagnoses.

There is one thing in Dr. Crane's paper that I wish to emphasize. I will admit that gastric analysis is worth very little in the diagnosis of duodenal ulcer if by stomach analysis is meant giving the patient tea and toast, which is then pumped out in thirty, forty, or fifty minutes and the laboratory findings on this content used as the basis of evidence. If with your ordinary test meal you get a proper return of high acid readings, accept the report. If the readings are low or the acid is absent you must do a fractional meal. You

are not privileged to draw conclusions without doing this.

We are accustomed to give every patient a motor meal. That precedes the gastric analysis for the ordinary Ewald test. With these meals we find a delayed emptying time of the stomach which the x-ray does not show. I remember a patient that Dr. Case showed. We reported a five hour emptying time. When we gave the barium with the regular meal the stomach did not empty for eight or nine hours—a case of duodenal ulcer.

A word about the operative confirmation of some of these cases. You remember, from the evidence at the Mayo Clinic, that some of these ulcers are very small and very difficult to see even when the duodenum is opened. Negative diagnosis made by the surgeon after putting the hand in the abdomen, feeling it, often without exposing it, makes no appeal to me. If there is definite roentgen evidence of duodenal ulcer I think it is worth while to insist that the duodenum be opened up and properly explored before the surgeon decides that ulcer is not present. It is frequently there when he says it is not.

Study of Hilus Pneumonias by Serial Radiographic Examination

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St. Louis, Mo.

THE recent influenza epidemic served to call the subject of atypical pneumonias to the attention of the medical profession. Serial radiographic examinations of these pneumonias, taken at intervals of from one to three days, revealed some very interesting data as to the modes of invasion, cause, and prognosis of the disease. While some of these types of pneumonias were familiar to the roentgenologist others had never been encountered before. To determine whether these types of pneumonia were peculiar to the influenza epidemic a closer observation was made of pneumonia cases occurring since the epidemic and serial radiographic examinations were made in all cases in which any atypical variety was found.

One particular type of pneumonia seen during the influenza epidemic [1] consisted of a consolidation limited to the hilus region. To some of these cases which proved very fatal the name of "critical pneumonia" was given by Ewing. The pathology in these cases was described as a zone of hemorrhage and pus completely ensheathing the bronchi in the hilus region and sweeping out to the periphery, choking off the patient's air supply. In others, after a very brief period, the temperature fell to normal by crisis, the patient having presented typical pneumonia symptoms, but few if any physical signs distinctive of pneumonia.

Among two hundred and seventy-six cases of primary pneumonia treated at City Hospitals, Nos. 1 and 2, during the past year, twelve such cases were found. None of the cases was in connection with the influenza epidemic and none of those reported occurred within one year of the last outbreak. The ages of these patients varied from twelve to sixty-two years. Although the two youngest patients were both twelve years of age, no other case was encountered under twenty-seven years of age, and the greatest number were over thirty years old. In practically all instances the disease followed exposure to cold, swimming, etc., and was preceded by a cough. A definite chill or chilly sensations marked the onset of all the cases. This was followed by a fever of continuous type and the temperature generally reached a rather high degree, attaining 105.8 in one case. The duration was from four to ten days, and in all but one case defervescence was by crisis. Pain in the chest was frequently encountered, but was inclined to be a dull ache in the middle of the chest or between the shoulders posteriorly rather than the sharp pain of pleurisy. In some cases, pain on pressure over the interscapular area was elicited. The sputum was bloody at some time during the disease in all cases, sometimes transitory, lasting only for a day, but at some time or other the sputum was blood tinged. The sputum was not a "prune juice" type in a single instance. The leukocyte count was usually high, from 16,600 to as high as 33,000. The only particular feature which was present in all cases was the almost total lack of distinctive physical signs. The patient, presenting an unmistakable picture of a pneumonia, was seen to continue day after day without appreciable physical signs. Occasionally there were a few rales posterior between the scapula and vertebral column, and in some cases sensitiveness to pressure over this area, but there was no change in percussion noted and no bronchial breathing. The rapid fall of the temperature to normal without development of physical findings might lead one to believe that the diagnosis of la grippe is often made.

This may also explain the small number of hilus pneumonias reported to have occurred in this large number of pneumonia cases; hidden under the diagnosis of la grippe, the cases were never submitted for radiographic examination.

In those cases in which radiographic examinations were obtained a sufficiently constant picture was presented to warrant description. Radiographic findings in these cases can be best outlined by separate consideration of the different types of consolidation en-

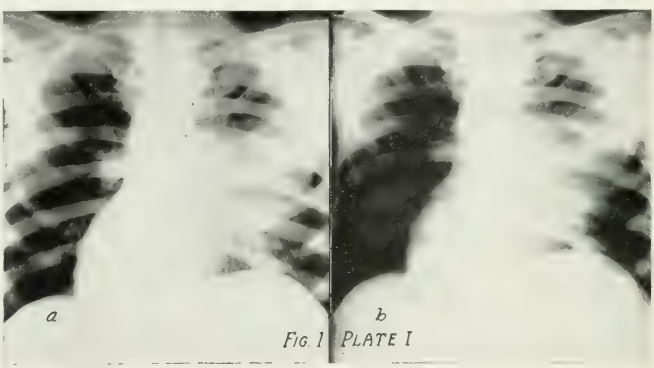

Figure I—(a)—Plate I—Acute inflammatory type of hilus pneumonia in an adult showing the most extensive involvement attained during the course of the disease. (b)—Plate I—A few days after crisis. The consolidated area resolves more by a shrinkage in size than by a decrease in density of the shadow.

countered and by a notation as to the age of the patients in whom they occurred, whether adults or children.

In the acute inflammatory type a consolidated area was noted in the hilus region on one side or the other (Fig. 1). The incidence of occurrence was about equally divided on the two sides, but in no case was a doubled hilus consolidation encountered. The consolidated area was well defined in the hilus region and extended outward into the lung. It was dense and showed little tendency to spread peripherally as the disease progressed. It was usually found to be as large within twenty-four hours after the onset of the disease as it ever became, and, in fact, at the first examination the area involved represented practically the most extensive anatomical advancement which the disease attained. It was not accompanied by a general haze over any particular lobe such as is often the picture encountered at the onset of a lobar pneumonia, and it was rarely associated with pleurisy or thickening of the pleura. In these respects it can usually be differentiated from lobar pneumonia, even when a single radiographic examination shows only a hilus consolidation with no accompanying haziness of the remainder of the lobe. Such consolidations do not remain confined to the hilus and rapidly extend to and involve an entire lobe of the lung. This condition does not pertain to hilus pneumonia, however. Under these circumstances some difficulty might be experienced from a single radiographic examination in differentiating the two conditions. Re-examination after twenty-four hours should always determine the character of the condition. No change can be noted in the consolidated area for a few days after the crisis, and resolution takes place more by a gradual shrinkage of the area involved than by a progressive decrease in the density of the shadow. From the character of the lesion and the course of the disease it is quite evident that these cases were pneumonias of inflammatory origin. One was in a child (Fig. 2), the others in adults. In all the cases of this series resolution was complete within two weeks after the crisis.

A second type of consolidation was encountered, very similar in radiographic characteristics, but more protracted in its course and associated with milder constitutional symptoms (Fig. 3). In this but little change was seen in the hilus shadow over a period of three months. An examination three weeks after the onset of the condition showed some decrease in the size of the shadow. Re-examination three months later, however, showed little change in the shadow from that seen at first examination. In this patient there was never high temperature, nor were there acute symptoms such as were encountered in the other cases. This case was in a boy twelve years of age and conforms to the cases described in the literature as recurrent tuberculous hilus pneumonia of children. This will be referred to later.

That this type of pneumonia existed long before the influenza epidemic there seems little doubt. It was probably in reference to this condition that Osler [2] said: "I saw in 1898, with Drs. H. Adler and Chew, a young thin-chested girl in whom at the end of the fourth day all the usual symptoms of pneumonia were present without any pathological signs other than a few clicking rales at the left apex behind. The general features of pneumonia continued and the crisis occurred on the seventh day." Considerable mention is made in the literature of central pneumonia [3] and every one with any degree of clinical experience has encountered pneumonia cases in which there was a delay in development of physical signs or an entire absence of adequate findings. Little mention is made, however, of the radiographic findings in these cases. Hilus consolidations are mentioned as occurring in children and it seems to be quite generally accepted that these are due to tuberculous origin. Sluka [4] and Eisler [5] have noted such consolidations in young children in association with cough and afternoon temperature extending over a period of months. Two similar cases have been reported by Greenberg [6] in children under two years of age. A recurrent hilus consolidation has been observed in children by Wessler and Bass [7] and Sluka [8] has reported twenty-one additional cases of this type (in his second report, thirty-eight in all) occurring within a period of less than two years. He does not state, however, that all of these cases were of the recurrent type, but does not question their

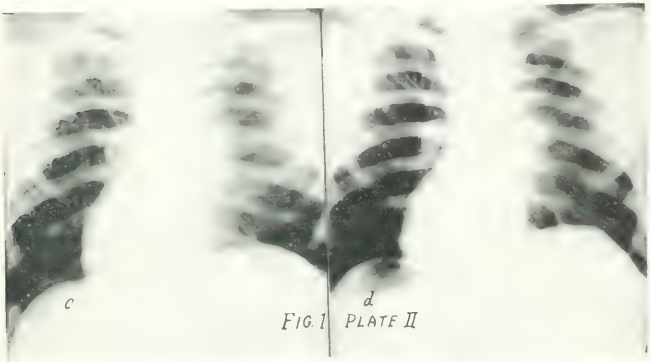

Figure I.—(c)—Plate II.—Resolution continues favorably. (d)—Plate II.—Within two weeks resolution is practically complete.

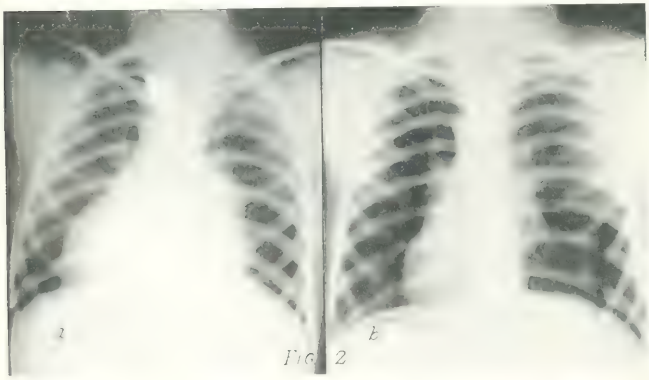

Figure II.—(a)—Acute inflammatory type of hilus pneumonia in a child twelve years of age; shows the most extensive involvement attained during the course of the disease. (b)—Complete resolution occurred within two weeks. Nothing to indicate a coexisting tuberculous lesion was found in the chest.

tuberculous origin. One of our series, previously mentioned, was of this type, showing very little variation in the extent of hilus consolidation over a three months period.

The mere persistence of a lesion over a period of months, does not, in my mind, establish it as tuberculous; in fact, the co-existence of tubercle bacilli in the sputum in a certain percentage of these cases would not be sufficient to establish the cause of the consolidation as tuberculous. The very fact of the ultimate resolution of the consolidated area, even if this does require months in some instances, is an argument against the tuberculous nature of the process. Lung puncture, although it would seem rather dangerous in the hilus area, has been performed in two instances where this condition existed, and was reported by Greenberg [6] to have yielded tubercle bacilli in one instance and, upon guinea pig inoculation, positive tuberculous findings in the other. This is, of course, evidence in favor of the tuberculous etiology, yet it cannot be considered as sufficient to establish the cause of the consolidation as being definitely due to tuberculosis. The question arises as to just what percentage of positive tuberculous findings would result if lung punctures were performed and material extracted from enlarged lymph nodes in the hilus region in patients not suffering from hilus pneumonia. The instances of co-existing evidence of tuberculosis elsewhere in the lung in our series of cases, after complete resolution, were relatively few, only four showing what would be considered evidence of incipient pulmonary lesions. In no case was actual consolidation present. Some mention is made of the possible inflammatory nature of even the protracted type of consolidation. Brandlier and Roepke [9] express some doubt about the tuberculous nature of these consolidations in children, but offer the explanation that they may be inflammatory reactions following the breaking down of old tuberculous lymphatic glands in the hilus. They explain the recurrent type of involvement as a succession of such reactions. While the predominating lesion in childhood may be one which is not rapidly resolved, the fact that hilus pneumonia can occur in children without question of tuberculous involvement, is evidenced by one of our juvenile cases in which an acute pneumonia was present, ending by crisis, and in which resolution was ultimately complete.

Aside from its mention in connection with influenza-pneumonias little has been said of hilus pneumonia in adults (Figs. 4 and 5). With the exception of our two youngest cases, both of which were twelve years old, the others were all over twenty-seven years of age, the oldest in the series being sixty-two. All of the adult cases likewise showed characteristic symptoms, which together with the brief course and rapid resolution, would be indicative of pneumonia of inflammatory origin. Of the juvenile cases, one was distinctly of the inflammatory type, the other of questionable tuberculous variety. The delay in resolution seen in the latter case does not preclude a possible inflammatory etiology. This has been clearly demonstrated by reports of cases of lobar pneumonia where there was a delay in resolution seen in the radiograph for a considerable period [10] and where final restoration to normal occurred without abscess formation or other pathological lesion. With regard to the inference that these consolidations are the result of inflammatory products thrown into the hilus region as a result of the breaking down of old tuberculous lesions, would it seem logical to suppose that such an extensive inflammatory lesion might be provoked in the hilus region by the setting free of tuberculous material when it does not cause such reaction elsewhere in the body? In view of the fact that in the large majority of these cases, even in those occurring in children and supposed to be of tuberculous nature, resolution is ultimately complete, is it not more logical to suppose that the primary lesion is a pneumonic consolidation of the hilus of inflammatory origin, that it runs its course and resolves in the majority of instances, and that, in the few remaining cases where interfered with, this is due to the activation of old tuberculous lesions previously existing at this hilus?

In substantiation of this supposition may I cite one case (Fig. 6) not included in this series, which occurred in our experience. In this case the patient, an adult, developed hilus pneumonia while employed in the hospital. The disease progressed favorably, crisis occurred, and in about one week she was permitted to be up and about. Five days after she was allowed to be up, she developed an afternoon temperature, and the radiographic examination at that time revealed a small rarified area within the persistent hilus consolidation. At first the rarified area was thought to be a beginning abscess, but its rapid enlargement from one-half inch to four inches in diameter within two weeks, together with the absence of excessive expectoration or presence of fluid within the area at any examination, renders this doubtful. It was thought possible that there was a cavity in the interstitial tissue of the hilus rather than in the lung substance, caused by the breaking down of an old

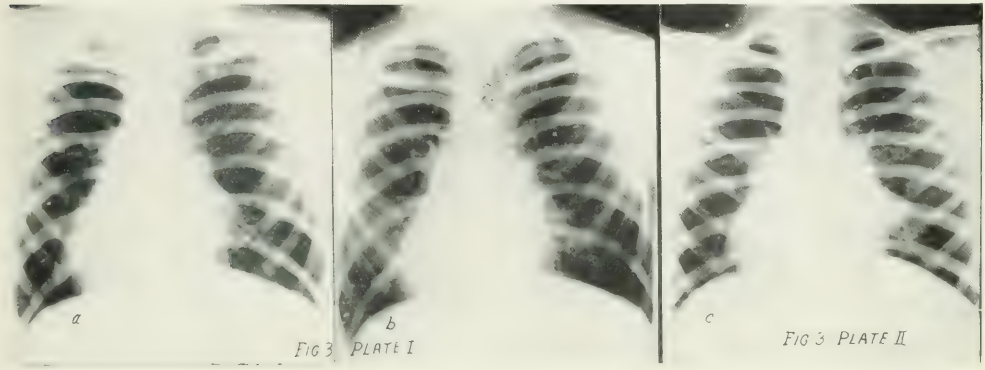

Figure III.—(a)—Plate I.—Protracted type of hilus pneumonia in a child—so-called tuberculous type, showing original consolidation. (b)—Plate I.—Some slight decrease in the hilus consolidation was noted three weeks later.
Figure III.—(c)—Plate II.—Examination after three months, however, showed a very extensive involvement of the hilus still present.

tuberculous lymph node. Tubercle bacilli were found in the sputum and the pathological condition in the lung showed little if any change over several months observation. Gradual retraction of the area occurred until in an examination made one year later, for which I am indebted to Dr. H. E. Kessler, a small, well walled off area in the hilus region was all that remained. This may explain similar shadows seen in the hilus region in other individuals, years after the acute process has healed. We have encountered one such case in which there was a history of pneumonia and protracted recovery.

In short, a pneumonic process of inflammatory type may involve the hilus region in either children or adults. Such involvement may terminate in complete and rapid restoration to normal in either case. Where a previous tuberculous process is present in the hilus, the inflammatory reaction may be sufficient to activate the old quiescent lesion. The difference in the nature of the reaction to such an activated tuberculous lesion in adults and children may be due to the predominating characteristics of tuberculous lesions of the hilus at different ages. In children the less confined character of a tuberculous lesion produces a more diffuse reaction, while in adults the heavy barrier of fibrous tissue about the lymphatics and the caseous lymph glands offers a better field for local disintegration and cavity formation.

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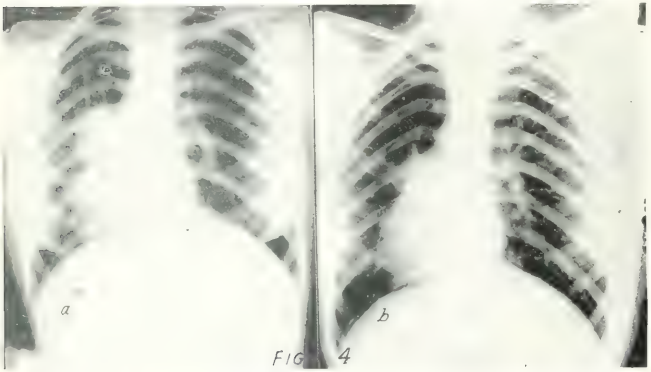

Figure IV.—(a)—Acute inflammatory type of hilus pneumonia in an adult. Radiograph, made within a few hours after the initial chill, shows that the maximum extent of the consolidation is attained within a short time. (b)—Complete resolution within two weeks.

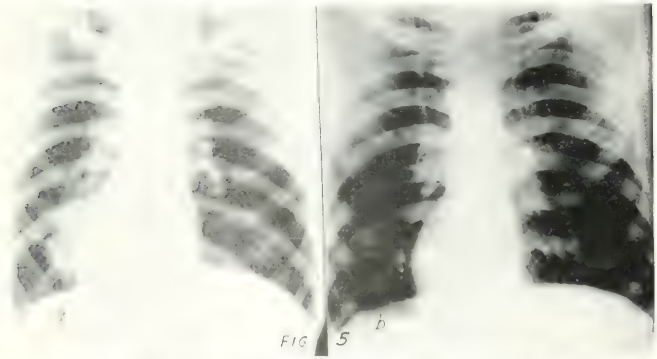

Figure V.—(a)—Acute inflammatory type of hilus pneumonia in an adult, showing a somewhat different appearance in the character of the hilus consolidation. (b)—Resolution complete within two weeks.

DISCUSSION

DR. STEWART *(New York)*: I was particularly interested in Dr. Sante's presentation. About five years ago I published an article describing the differential diagnosis of pleuritic effusion and pneumonias in children. I described three forms of pneumonia. Dr. Sante calls it hilus pneumonia. I called it a root pneumonia. There are certainly three distinct classes—ordinary lobar, so-called root pneumonia and bronchial pneumonia.

In the lobar pneumonia, or cortical pneumonia, the process always commences at the pleural surface. It assumes a triangular form working towards the root with the apex at that point when the full consolidation is reached.

The difficulty with physical signs during the period of the extent of the pneumonia from the pleural surface to the root is quite evident, and I make the assertion that in many cases of pleural pneumonia roentgenologists could make a diagnosis at least three days before the physical side is apparent.

I make this on the basis that it is due entirely to the break in the sounds carried from the solid area to the larger bronchi in which it has to pass from a solid section into a well aerated section before it reaches the bronchi. As soon as the consolidation reaches the apex of the root, bronchial breathing is heard.

Dr. Sante's experience with root pneumonia is a little different than mine. The reverse is the case of a statement I have just made, because with the consolidation at the root, the sounds are conveyed almost immediately, and at

least my experience with the men with whom I am associated is that they have been able to recognize the process very early.

It is this form of pneumonia that is called a four-day pneumonia. If you have had experience with children, clinically, you will know there is a class called a four-day pneumonia in which resolution occurs very early. This is the process that occurs at the root involving more than one lobe. In result it is very interesting, particularly postoperative cases. Many cases are referred to you that have undergone a surgical operation. On the fourth day there is a sudden rise of temperature, many signs of consolidation of the lung and upon roentgen examination you fail to find any evidence of a pneumonic process.

If you will bear in mind that most of these cases are root cases and look carefully at your hilus, in many instances you will find the cause of the trouble.

Dr. Sante's case where he showed an apparent increase in the size of the cavity is most interesting. It seems rather rapid to be an abscess. I am more inclined to believe it is a pleural effect. I would like to ask the doctor if the studies were made stereoscopically? Perhaps that would enlighten us.

It brings up a most interesting subject, and that is the value of the lateral position in the examination of the lung, particularly in those acute processes. I wish those who are doing much lung work would take advantage of the lateral position. You would be perfectly surprised to see the difference in the size of the cavities in lung abscesses as they appear in the lateral and in the erect.

I mean by the lateral position that the patient lies on the side, the tube is placed at the back and the tube is placed in front. Only recently I had a case of that character in which there was demonstrated a very marked movement of the entire mediastinal contents. I took the matter up with Woolimeyer and he seemed as much surprised as I did as to the visible evidence of a movement, a mediastinal movement or movement of the contents of the mediastinum to the opposite side.

DR. RICHARDS: I just wanted to ask the doctor if he has done any work on the treatment of these central pneumonias. I want to ask Dr. Sante that.

DR. SANTE: Mr. Chairman and Gentlemen: To Dr. Stewart's remarks, I would say that only two of our cases were in children. One was of the supposed tuberculous type, one of the inflammatory type. That of the inflammatory type lasted ten days. In neither case were there distinctive physical signs. Most of the cases were adults. There was slight tenderness on pressure between the scapula and the vertebral column on that side, possibly a few clicking rales (I am accepting the statements of the clinician that had the case) no definite dullness from consolidation, no blowing breathing, nothing distinctive of pneumonia.

The average duration of these adult cases was seven days. None of these cases occurred after operation or in complication with any other disease. I made it a point to exclude all of these cases.

With reference to the annular ring, I would say that the first three or four sets of plates were made stereoscopically. The others were simply flat plates. Dr. Kessler's, taken six months and a year later, and made stereoscopically, showed the annular ring to be in the hilus region, not at the periphery.

There was one thing about tuberculosis in children. We have quite a number of children at the Cook Hospital for Tuberculosis in St. Louis. I may say that while, of course, I realie that it is the exception, still we have several children there with massive involvement of an entire lung with cavity formation, some of whom have had tubercle bacilli in the sputum for two and a half years. I refer to children five and six years old.

With reference to Dr. Richard's statement as to treatment, of course, I assume he means medical treatment. They get well by themselves. Resolve within ten days and get all right.

DR. RICHARDS: I mean x-ray treatment of chronic pneumonia.

DR. SANTE: No, we have not, mainly because we have not been able to control them. We were not able to get a single case back for further examination after three months. If the patient feels all right he won't come back.

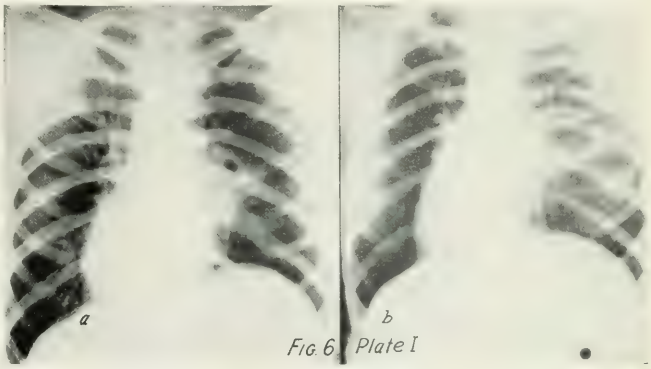

Figure VI.—(a)—Plate I.—Acute inflammatory type of hilus pneumonia in an adult, with complications, showing a small rarefied area within the persistent hilus consolidation. About two weeks after crisis. (b)—Plate I.—Radiograph taken six days later. The rarefied area continues to enlarge

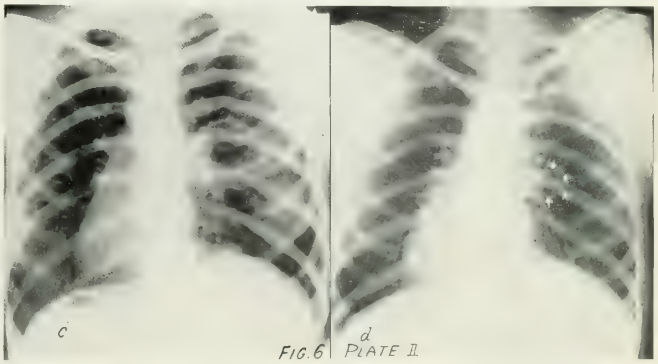

Figure VI.—(c)—Plate II.—This rarefied area enlarged from one-half to four inches in diameter within two weeks. This persisted for six months and never attained a much larger size. (d)—Plate II.—Examination one year later showed that the rarefied area had shrunk to a small size, but was still discernible as a ring in the hilus region. Tubercle bacilli were found in the sputum. (Courtesy of Dr. H. E. Kessler.)

Radium and Roentgen Ray Therapy in Malignancy: Indications, Contra-Indications, Limitations and Recent Developments*

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THE use of radium and roentgen ray in the treatment of certain diseases is gradually assuming a more and more important place in medicine. This is particularly true of malignant conditions, in the treatment of which radiation bids fair to become increasingly important. Unfortunately the proper evaluation of these agents, as in the case of all other therapeutic agents in their early days, is being made more or less difficult by the usual troubles of youth and by more or less exaggerated claims. All of this brings forth, from the less interested members of our profession, indications of a skepticism which, even if at times partly unwarranted, is bound in the long run to help us maintain a more judicious and more sanely critical attitude toward our work.

If we wish our progress to be steady and as free as possible from the missteps and reversals which have marked the development of every branch of science, we must base our practice on sound principles and formulate our technique from information laboriously and patiently obtained by the physicist, the biologist, and the pathologist.

Before considering more in detail the use of radium and roentgen rays in the treatment of malignancy, I should like to emphasize briefly certain well known fundamental factors, the importance of which is not always sufficiently realized. Some of these factors impose on us limitations that we are constantly striving to overcome.

Inverse Square Law

As we know, therapy by radiation is absolutely dominated by the inverse square law, the practical importance of which is so great that in making any application of radium or roentgen rays, it should automatically become the radiologist's first consideration.

For example, if a tube of radium is placed with relation to a malignant growth the intensity at points 0.5, 1.0, 5, and 10 cm. from the tube will be, respectively, 1, 1 4, 1/100, 1/400 (taking as a unit the intensity at 0.5 cm.). If the dosage was correct for a distance of 5.0 cm. from the tube, it must follow that the portion at 0.5 cm. will be burned by a dose one hundred times too great, while the portion at 10 cm. distance will receive little or no therapeutic effect. In principle, this law applies to both radium and roentgen rays. While this difficulty cannot be overcome completely, its consequences can be avoided to a considerable extent, as far as roentgen rays are concerned, by increasing the distance between the tumor and the source of radiation. We can thus minimize the difference between the intensity of the rays as they enter the proximal surface of the tumor and as they leave the distal surface. In other words, the different parts of the tumor will receive a more uniform quality of radiation. However, the associated disadvantage is a great loss in the total intensity available, a loss which must be compensated by a great increase in the time of exposure.

Another way of avoiding the consequences of the inverse square law is to increase the number of sources of radiation; this may be accomplished by multiplying the number of areas treated. In this way, as many multiples of a single dose may be concentrated into a limited internal area as the number of different superficial areas through which the treatment can be given. This latter method should be selected in treating a tumor situated at approximately equal distances from two opposite surfaces of the body. In some cases a combination of the two methods may be advisable or necessary. However, should the tumor be superficial, increase in focal distance alone is to be preferred as a means of increasing the dosage delivered to the tumor. Such increase in distance should, of course, be adequately compensated by increase in time of exposure.

The only way to overcome the handicap of the inverse square law with any degree of effectiveness in the case of radium is by burying the radiation units in the tissues and increasing the number of those units. This may be accomplished by inserting into the tissue tubes of radium emanation which are allowed to remain in place either temporarily or permanently. However, because of the short and rapidly decreasing period of activity of radium emanation, and because of the necessity of leaving in place the small glass containers, but particularly because of the intense necrosis produced around such unfiltered radiation elements, the use of buried emanation, while undoubtedly of great value in many cases, will probably be gradually replaced, at least to some extent, by the use of radium needles containing a definite quantity of radium salt of stable activity. These needles, with varying degrees and qualities of filtration, aid in avoiding some of the tissue necrosis occurring around an unfiltered glass emanation unit. Such necrosis is definite and complete within a zone, the extent of which is proportionate to the radium content of the tube. (2)

The question of filtration is becoming more and more important. We know that the rays from a roentgen ray tube or from a radio-active substance, such as radium or its emanation products, are not homogeneous, that is, they are not made up of rays of one wave-length. On the contrary, such rays are extremely heterogeneous, being composed of a mixture of rays of all wave-lengths. The longer, being easily absorbed or weak in penetrating power, do not pass beyond the first layers of tissue cells, while the rays of shorter wave-lengths penetrate deeper and deeper into the tissues. This complex character of roentgen rays and radium rays, to which their unequal absorbability is due, constitutes another major limitation in efficient therapy by radiation, a limitation almost as great in its effects as the inverse square law. Such limitation may be minimized to a considerable degree by filtration. In treating a malignant tumor with roentgen rays, attack must generally be made through the skin or mucous membrane, both of which are extremely sensitive to so-called soft rays, or rays of long wave-length. This fact has brought grief to many radiologists in the past, and we still occasionally are reminded that the skin will withstand only a limited degree of insult. By adequate filtration, wave-lengths least injurious to the tegument can be selected. In other words, the softer rays are absorbed by the filter which prevents them from injuring the skin or mucous membrane. Another very important point is accomplished, namely, an increase in the homogeneity of the effective radiation, or rather a decrease in its heterogeneity.

* —Presented before the Radiological Society of North America, December 7-9, 1921, Chicago.

The situation with regard to radium is quite different. If we wish to treat a lesion by external application we must use heavy primary and secondary filtration in order to avoid serious burns. One millimeter of platinum or its equivalent will filter out all the β rays and the less penetrating portion of the γ rays. Two or three millimeters of rubber will eliminate the secondary rays generated by the primary radiation in the metal used as a filter. If we wish to attack a lesion by burying in it radium or its emanation, filtration may not be necessary, especially in tumors of relatively small size. Around each unit of radium or its emanation so placed, there occurs destruction in the form of necrosis which may be more or less extensive according to the dosage. Beyond this zone of necrosis, the tissue constituents of which act as a filter, a so-called selective effect is obtained. The tissue adjoining the radio-active substance filters out the softer, less penetrating rays, to which the necrotic effect is due, and the effect of that portion of the radiation which has gone through this zone unabsorbed then depends on the radio-sensitiveness of the tissue cells outside that zone. When buried emanation is used the zone of destruction is greater because nearly all of the β and γ radiation passes out of the glass tube; whereas with platinum needles, or other filters of relatively high density which allow the escape of only the more penetrating portion of the β and γ radiation, the zone of destruction is more limited.

By far the most serious limitation in the diagnosis and treatment of pathologic lesions springs from the fact that we must depend almost entirely on our human eyes and hands. These are very gross instruments and, even with very effective therapeutic agents, we can never hope to accomplish the cure of more than a certain proportion of the malignant diseases we may undertake to treat. Those of us who have had experience with pathologic conditions found at necropsy know but too well the uncertainties and deceptions of our methods of physical diagnosis. Some consolation may be derived from the fact that the radiologist's limitations in this respect are shared equally by the surgeon and the internist. It is a very common occurrence to find that a malignant lesion supposedly limited to a certain organ or tissue had actually become much more widely disseminated either by direct extension, by metastasis, or both. The only way we have of combating this limitation is by impressing on the public and members of the profession in general the extreme importance of early diagnosis and treatment. Although something can be accomplished in this direction, the very limitation in the acuity of our senses often makes an early diagnosis in the first instance difficult. It is not unusual to be told by patients that when they first consulted a physician concerning a lesion which appears to have been an early manifestation of a malignant process they were told that it was of no significance and that they should promptly forget it. Such instances influence us to conclude that physicians are as much in need of "education" as the public in this most important matter.

Indications and Contra-Indications for Radium and Roentgen Ray Therapy

Our first consideration must be the diagnosis; because, if we are to utilize radium or roentgen ray therapy with any degree of success, we must know the nature of the lesion we wish to treat. Not only should we know the type of malignancy, but as many as possible of its salient features, such as the predominating type of cell, and reaction factors. It is not always possible, nor in some cases is it necessarily advisable, to obtain such complete information. Judgment should be applied to the individual case. The lack of a definite diagnosis constitutes a fundamental contra-indication to such treatment. The other important contra-indications are:

1. The bad general condition of the patient, making it impossible or dangerous to administer really adequate treatment.

2. Tumors complicated by infection. This condition is not infrequently encountered, especially in association with carcinoma of the uterus, but occasionally also in other locations such as the breast. In such cases drainage and other general measures must be instituted before radiation.

3. Lack of suitable apparatus, or the knowledge requisite for its proper use. We occasionally still hear of physicians attempting to treat malignant conditions with such facilities as are provided by an ordinary portable bed-side unit.

Radium is particularly indicated when we are dealing with a fairly small lesion or tumor at or near the surface of the body (or reasonably accessible from the outside) and the extent of which can be outlined with a fair degreen of accuracy. Its ideal indication is in conditions in which it is possible to introduce the agent into the substance of the lesion in such a manner as to deliver to every part fairly uniform radiation in adequate dosage.

At the present time radium, alone or in conjunction with roentgen rays, is indicated and should be used (preferably by the needling method) in cases of solitary glandular carcinoma or sarcoma of limited size and well defined extent, especially on or near the surface of the body; and in cases of solitary or discrete, superficial, malignant gland or cutaneous metastasis. Malignant conditions in cavities accessible from the body surface (uterus, vagina, rectum, bladder, mouth, nose, larynx and esophagus) should preferably be treated with radium or its emanation, usually in conjunction with external roentgenization. In cancer of the uterine cervix, for instance, radium achieves marvelous results in many cases because the element can be introduced into the cervical canal and is there surrounded on all sides by the neoplastic tissue. From our present knowledge the method of employing therapy by radiation to the best advantage in such conditions would seem to lie unquestionably in the combination of radium internally and roentgen rays externally.

The γ rays of radium are more penetrating than the roentgen rays used at present for therapeutic purposes. Experimentally, roentgen rays have been produced with wave-lengths as short as some of the γ rays, and these may be available before long. However, with the small dosages commonly used, the total radio-active energy delivered to a lesion or tissue beneath the surface is very small, and constitutes an extremely small fraction of the total γ radiation generated by a given quantity of radium. Furthermore, our present means of employing radium for therapeutic purposes are such as to make it impossible to deliver uniform radiation to a lesion of any extent on the surface. This difficulty is magnified many times when we are dealing with a deep lesion the exact extent of which cannot be outlined accurately. These factors determine in a very large measure the indications for the use of radium or roentgen rays.

Roentgen rays act at a more uniform intensity over a much wider field than radium rays. Although their intensity decreases rapidly as they pass from the surface to deeper and deeper tissue layers, a portion of this loss can be compensated by increasing filtration, focal distance, and the number of so-called ports of entry. Therefore, if we are dealing with an extensive superficial lesion or with a lesion, either superficial or deep, whose exact extent cannot be fairly accurately outlined, roentgen rays are the agent of choice. Tumors with a tendency to metastatic dissemination by way of the lymphatics,

or growths in which metastasis is suspected or to be expected, should be treated either by roentgen rays alone or combined with radium. The neck with its complicated lymphatic system in malignancy of the mouth or face, and the thorax and axilla in cancer of the breast serve as illustrations.

Combination of roentgen rays and radium.—Although the indications for roentgen rays or radium are usually quite well defined, there are many cases in which both should be used in conjunction. As a matter of fact, the ideal method of treating many malignant tumors is by a judicious selection or combination of surgery, roentgen rays, and radium. In selected cases, surgery should be a preliminary step to prepare the field and to permit direct visual application of the radium, to be supplemented or not by roentgen radiation. If anything really substantial is to be accomplished in the therapy of malignant conditions by radiation, our procedure must be based on one essential requirement. The entire involved area with its lymphatic drainage, must receive a uniform lethal dose, which should be delivered, as nearly as possible, during the first treatment. I do not mean to imply that it is necessary to give such dosage at one seance, but the treatment should be completed within as short a period as the condition of the patient and the degree of reaction will allow. To scatter a course of treatment over a period of weeks is to defeat the very purpose we are attempting to achieve. If involvement is limited and it is reasonable to expect a cure, we should aim to destroy the malignant elements by one attack. As heavy dosage as the integrity of important neighboring structures will allow should be administered with adequate filtration in order to minimize as much as possible the deleterious effects of the long wave-length portion of the radiation. Limited radiation with limited dosage is to be used when a cure is out of the question and only palliation is to be expected.

The importance of treating the lymphatic system draining the area of a malignant tumor cannot be overemphasized. Untreated elements not uncommonly show signs of activity. This is of especial importance in carcinoma, the dissemination of which takes place so largely by way of the lymphatic system. Although this consideration might seem self-evident the manifest lesions only are often treated in a scattered fashion and the lymphatic drainage system overlooked. In fact, in most malignant conditions the lymphatic drainage system should be treated before attacking the main lesion. In general, we should adopt the same procedure in sarcoma, although in these cases dissemination by way of the blood stream is the rule. The anatomy and physiology of the circulatory system and the general pathologic features of carcinoma and sarcoma enable us to understand why in the former metastasis usually takes place through the lymphatic system but in the latter occurs by way of the blood stream.

Sarcoma, especially sarcoma of bone, has a very great tendency to metastasize to the lungs. [1] It is difficult to say why this is true. There seems to be very little doubt that the dissemination of metastatic elements or emboli takes place quite early and the reason many of these do not lead to gross secondary lesions possibly is due to the activity of some defensive mechanism elaborated in the body fluids as the result of the antigenic action of the primary growth. An explanation of the fact that metastatic elements which give rise to secondary lesions have such a predilection for the pulmonary organs may perhaps be found in the fact that the pulmonary circulation constitutes the first capillary bed through which the blood from the general circulation passes.

Whatever may be the truth with regard to metastasis, the questions arise: Should we make it a routine practice to radiate the mediastinum and lungs in sarcoma in the hope of destroying metastatic deposits, even if not demonstrable? Should we radiate the mediastinum and lungs at all? Should we treat only these organs or should we attempt to radiate the entire trunk on the basis that, while pulmonary metastasis is the most frequent site, metastasis not infrequently occurs in other organs?

In a recent personal communication, Bloodgood writes with regard to this question: "In a number of cases the x-ray (examination) of the lungs was negative, and after amputation, radiation of the chest was performed on one or more occasions; in spite of which metastasis developed. Similar observations in three cases of sarcoma of the soft parts. Up to the present time I have no evidence that radiation of metastasis of the lungs has had any effect even if done before metastasis shows in the x-ray." From this statement we are forced to accept one of the three following conclusions: (1) the dosage was inadequate, (2) the quality of the radiation was not suitable, or (3) radiation will not achieve the destruction of such metastatic foci. There is the further possibility that if radiation is to be really affective in controlling metastatic dissemination to the lungs not only the mediastinum should be treated, but also the lungs, because metastatic emboli must often be carried beyond the larger radicles well into the substance of the organ.

If an attempt is made to administer so-called prophylactic treatment to the contents of the thoracic cavity for metastatic sarcoma or carcinoma, such treatment should be extremely thorough and should be given early, even though it be impossible to demonstrate metastatic foci.

Unfortunately, in the majority of cases when the liver or lungs become demonstrably involved, the condition is usually almost hopeless. We may, however, look forward to the time when further developments in technique may make it possible to do more toward checking metastatic deposits. Pfahler has shown that in some cases it is possible to influence the development of metastasis in the bony substance of the vertebral segments. However, we are not justified in increasing the discomfort and suffering of a dying fellow-being when we know that all our previous efforts to cure him have been unsuccessful.

The group of malignant conditions classified under the general head of lymphoblastoma, which includes Hodgkin's disease, lymposarcoma, and allied conditions, presents a difficult problem. Characterized as these are by a tendency to progressive involvement of the lymphatic elements their exact status remains unsettled. In many cases in which the cervical glands are enormously enlarged, we can obtain a rapid and at times a truly startling reduction by means of radium. Other important groups of glands such as the mediastinal, and paravertebral, should also be treated, and this can be done most efficaciously by roentgen rays. It is questionable if the reduction of enormous adenopathies by radium may not in some cases be too rapid, and if a more gradual, though slower, regression would not yield better results. For the present we must be guided by our judgment in individual cases.

Preoperative radiation.—The practice of radiating a region after preliminary surgical amputation of the grossly malignant tissue has become a routine practice in many cases as in carcinoma of the breast. Although a sound technique may yield good results, it is doubtful if our hopes are really justified or will be realized. Often operation performed with the intent to rid the patient of cancer leads to more or less rapid dissemination by grafting, or by venous or lymphatic absorption. The rational procedure, therefore, would seem to be for the surgeon not to op-

erate before the involved part and its lymphatic drainage have been thoroughly radiated. Aside from the principle involved this would be of decided advantage in cases of carcinoma of the breast particularly, because the radiation could be administered much more effectively before operation, since there would not be a recent wound to prevent the arm from being well abducted. The entire axilla could thus be much more thoroughly and uniformly treated, and the tendency to malignant cell dissemination at the time of operation would be diminished. This principle may be applied to the surgical treatment of malignant conditions in general, except, of course, in the cases in which surgery is intended as a preliminary step before radiation.

The surgeon wishes to know how long an interval should be allowed between radiation and operation. The early response of tissues subjected to radiation consists essentially in a modified inflammatory reaction, beginning as usual with edema; the reaction is more intense and more localized, if radium is used, and less intense and more diffused if roentgen rays are used. The tissue cells gradually recover if the dose has been light; there is inhibition of their reproduction and development if the dose has been moderate; the cells may be completely destroyed if the dose has been lethal. The products of such destruction are removed by autolysis and absorption, and later are replaced by fibrosis. This is true of normal as well as of pathologic cells. Generally neoplastic cells are more sensitive to radiation than normal tissue cells, and on this fact is based the entire radiation treatment of malignancy.

In many patients radiation produces so-called deep radiation sickness, a temporary state characterized by nausea with or without vomiting which may be quite pronounced, anorexia, headache, a sensation of general weakness, nervousness, and sometimes by fever. This state may last in some degree for from a few hours to several days; a few patients remain nauseated and weak for as long as two weeks, during which time they eat little and lose weight. Such reaction, which is usually shorter and much less severe in persons treated with radium than in those treated with roentgen rays should be allowed to subside completely before the patient is subjected to the ordeal of a major operation.

As a rule, severe reactions are observed only when some part of the abdomen has been treated, and this is particularly true of the upper half. Therefore, the interval between radiation and operation must depend largely on the relative importance of these factors in a given case. In carcinoma of the breast radiation sickness is usually either absent or slight and so the operation could readily follow within a week. In carcinoma of the uterus, however, the radiation is administered by means of radium internally and by external roentgenization, and the interval should be from three to four weeks .

After radiation the tissues should be in comparatively good condition for operation, and the surgeon should not encounter any particular delay in the repair of the wound. It is doubtful if the surgeon will have any difficulties in carrying out the various steps of the operation, after a single course of treatment, especially if a proper interval has been allowed before operation. Even though the operation is made more difficult by radiation, few surgeons would hesitate to adopt it if the final results from the standpoint of the patient can be improved. Preoperative radiation should also tend to minimize the danger of tampering with a malignant lesion in order to obtain a specimen for diagnosis.

Postoperative radiation.—Postoperative radiation may be and often is more or less illusory. The most important requirements in rendering innocuous such invisible malignant elements as may have remained after surgical ablation is a correct selection of the agent and its use in adequate dosage. Should radium or roentgen rays be used? If we wish to sterilize an entire region, as following removal of the breast, radiation should be administered not only to the field of operation, but to its lymphatic drainage. Roentgen rays properly applied will best meet the condition. Radium should be reserved for small well-defined territories, especially if the agent can be introduced into the center or the substance of the tissues, as the vaginal vault following hysterectomy (in conjunction with roentgen rays from the outside), or into the cavity left after the removal of a tumor of limited size. However, in the latter, the radium should preferaly be introduced at the time of and as a part of the operation. Radium used postoperatively, and blindly pushed or slipped into a drainage tube placed by the surgeon at the time of the operation is, at best, a very uncertain procedure.

If there has been no preoperative radiation, the patient should receive the treatment as soon as possible after operation. If the operation has been preceded by radiation the postoperative interval must be governed by the preoperative interval; due consideration should be allowed between operation and radiation. In cases of carcinoma of the breast treatment might be commenced within one week, whereas it might seriously jeopardize the patient's chances of recovery if radiation were begun so soon after an abdominal operation.

How often should this postoperative, or so-called prophylactic radiation be repeated? In the absence of glandular involvement if the dosage has been estimated correctly, two to three thorough courses of treatment should be sufficient, particularly if one of these courses has been administered before operation. If the dosage has not been correctly estimated, however, we can hardly expect to achieve good results by prolonging our efforts indefinitely.

Recent Developments in Technique

During the past few years radiologists and members of the medical profession in general have been startled out of their usual complacency by reports of wonderful advances in the roentgen ray therapy of malignant diseases. Such reports have emanated very largely from German clinics and have led us to believe that very much better results can be obtained than formerly.

A study of original sources and the reports of several American observers in Germany show that no two of those clinics employ the same technique. Although there is a wide difference of opinion with regard to many details in the application of treatment, there is a reasonable degree of unanimity on a few points: (1) the use of higher voltage; (2) the use of "higher" filtration and the advantages of copper or zinc over aluminium as a filter; and (3) the use of increased focal distance. There are strong theoretical reasons for believing that these factors will exert a great influence on pathologic processes of a neoplastic nature, but only time and greater experience will enable us to decide whether or not such influence will be purely beneficial and to what extent.

Seitz and Wintz [5] have advanced the idea, based on what seems to be very painstaking research, that different malignant and other conditions respond to definite dosages. Thus, they have found that the dose for carcinoma lies between one hundred and one hundred and ten per cent of the unit skin dose; the dose for sarcoma is given as from sixty-five to seventy per cent, and the dose for castration was determined to be thirty-five per cent. These figures, I believe, were not intended to be interpreted too literally. It would be very difficult indeed to reconcile any such fixed limits of dosage with what we know of the very considerable variability in the metabolism of a given type

of malignant cells. For example, in carcinoma there is often a tremendous difference in activity between tumors in patients of the same age, not to mention the variable activity of tumors in patients of different ages. Even the influence on the growth of tumors of such factors as lymphocytic infiltration, fibrosis, differentiation, and hyalinization, either singly or in combination[3], make it very difficult to accept such arbitrary ideas of dosage.

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Roentgen Ray Anthropometry of the Skull*

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Letter of Transmittal

Dr. A. W. Crane, Chairman
Dr. P. M. Hickey,
Dr. H. K. Pancoast,

Members of the Committee of the Leonard Prize for Research.

Gentlemen:—

A research submitted in commemoration of the memory of Dr. Charles Lester Leonard should possess, I believe, two essential attributes; in the first place, it should be a research original in the sense that the labor involved in its pursuit was inspired as an unselfish offering of devotion to the immortality of the martyred pioneer; and, secondly, it should represent a concept born wholly of American ingenuity for which Doctor Leonard was especially famed.

X-rays, radium and radio-activity present phenomena of limitless variety; so that it is not difficult to select a theme for research, the subject matter of which has not yet been investigated. The selection of a subject matter is necessarily modified by the circumstances of environment in which the investigator is immersed. The selection, therefore, of the topic of roentgen ray anthropometry was made on the basis of originality of concept, there being no consciously propounded and scientifically defended system of x-ray anthropometry anywhere extant; and made also because of the possibility of serving the interests of arts and sciences other than medicine alone.

There are other themes, some of them possibly more absorbing and in which the medical profession of an entire world is at present interested, that could have been selected for investigation. But these avenues of research already have established precedents; and their further study could hardly be considered original, but rather additional research. For this reason the fruitful field of x-ray or radiotherapy was entirely excluded.

It is a pleasure to be permitted to offer this thesis for the critical consideration of your committee; for if the announcement of the Leonard Prize for Research has stimulated in others, as it has stimulated in me, a sense of imaginative originality and a desire to emulate an American leader in x-ray, there can be no doubt that the collected efforts will serve as additional supports to maintain American x-ray activity as a world example of scientific achievement.

Respectfully,

A. J. Pacini.

June 24, 1921.

Introduction

THE province of physical anthropology has for its scope a comparative study of the human body and its inseparable functions. It treats of the causes and ways of human evolution and with the development, transmission, classification, effects and tendencies of man's bodily and functional differences (Hrdlicka). From which it may be gathered that the methods of physical anthropology are in many instances the methods of medical diagnosis, more especially in the study of morphologic changes incident to aberrant functions of the endocrines.

It does not appear that roentgenology has heretofore been propounded as the basis of an anthropometric system useful alike in anthropologic medicine and in medical anthropology; and this thesis presents a propounded and defended system of roentgen ray anthropometry useful to serve both the anthropologist and the physician in the common objective of the study of "human evolution, development, transmission, classifications, effects and tendencies of man's bodily and functional differences."

Modern science is based on the record of past investigation. This condition must, therefore, apply to roentgen ray anthropometry, which is essentially a new science. If the roentgen ray is to serve as an agent fundamental in a system of anthropometry, it is obvious that the method involved must meet the rigid requirements of anthropometry established by the Monaco and Geneva Agreements. As there are also certain standards that must be met by roentgen ray methods, the thesis divides itself into Part I, where the technique of the investigation is first critically considered; Part II, where the principles common to physical anthropology and to roentgen ray anthropometry are discussed, followed by the records of measures of anthropometric entities such as diameters, angles and indices in a series of skulls; Part III, which includes the measures derived by the system of roentgen ray anthropometry elaborated, and contact prints of the skulls from which these measures were derived; and Part IV, which is a bibliographic reference list carefully compiled and of attested accuracy, including references only to such articles as have a direct bearing on the various topics in anthropometry presented in the thesis.

In connection with roentgenologic methods appreciative acknowledgment is extended to Dr. Leon T. LeWald, Dr. William M. Manges, Dr. Frederick M. Law and Dr. I. Seth Hirsch, and to Dr. E. W. Eldridge, who conducted all of the exposures, the prints

*—This thesis was awarded first place in the Leonard Research Prize Contest offered by the American Roentgen Ray Society during the year 1921. It was submitted under motto:

"[illegible] received depends upon the man."

of which appear in the accompanying atlas.

To Dr. William A. White, superintendent of the Saint Elizabeth's Hospital for the Insane, and Dr. Walter F. Treadway, Chief, Section of Neuro-Psychiatry, Hospital Division of the United States Public Health Service, thanks are extended for permission to make use of some of the many mental defectives under care at the Saint Elizabeth's Hospital.

Before propounding this system of roentgen ray anthropometry it was desired conclusively to establish for it the same degree of accuracy usual to physical anthropologic methods. To gain this, instruction in anthropometry was had at the United States National Museum [1] under the personal instruction of Dr. Ales Hrdlicka, to whom appreciation is extended. The sliding and spreading compasses used for the measure of skulls to serve as standard for x-ray measures were obtained from Collin, Paris, through the help of Mr. Louis Leonard Shapiro.

Thanks are extended to Mr. Earle T. Bailey, who shared in the labor of reporting the measures taken and who contributed thoughtful suggestions in the matter of the design of certain instruments which will be described.

All of the references contained in the bibliography were procured by Miss Margaret Doonan, Librarian, office of the Surgeon General, U. S. Public Health Service. Many more volumes were consulted than are recorded in the bibliographic list; so that the work contributed by Miss Doonan in securing the necessary books from the various sources was even greater than would appear from the number of references recorded. It is desired to acknowledge every appreciation of her untiring and zealous assistance.

The contact prints that appear in the atlas were prepared by S. W. Nourse, whose co-operation in this matter is appreciated.

Finally, the labor involved in the preparation of the manuscript was shared by Miss Elmira R. Poteet, Miss Deborah Aaron and Miss Anna A. D. Rekus, and to these stenographic assistants my greatest thanks are extended for their faithful endurance in bringing to a conclusion what must have been for them a most tedious task.

PART I.

Technique of the Investigation

Apparatus

THE selection of adequate apparatus for the pursuit of roentgen ray anthropometry is determined by two factors; first, it must include all those appurtenances that contribute to the production of the median sagittal projection of the cranium, combining accuracy and simplicity; and secondly, it should not necessitate additional, nor more elaborate apparatus than that allotted to the average roentgen ray laboratory.

There exist many forms of head immobilization apparatus, such as that pictured in Hirsch's "Principles and Practice of Roentgenological Technique" [2] representing the model introduced by Dr. Percy Brown; but the simplest apparatus is the vertical stereoscopic plate changer. This apparatus is usually a part of the equipment of all laboratories; though in its stead, any vertical plane against which the head may be rested will suffice for this investigation. A modern transformer of the usual type, and adequate to furnish thirty milliamperes of current and six inch spark gap, will be found a satisfactory generator. Either Coolidge or gas tubes can be used. It would seem that plates make for greater definition than is obtained through the use of duplitized x-ray films; but the facility in handling and especially in the storing of films is so great as to make their use of practical advantage over the use of plates.

In exposing the head, teleroentgenographic technique (the removal of the tube two meters from the film) makes for minimum distortion of the projected skull srtuctures. However, even at this distance, there is some distortion by reason of the fact that the median sagittal plane of the head is removed from the film and also by reason of the fact that at two meters the emergent x-ray bundle consists of rays that are nearly, but not absolutely parallel. In addition, as the distance is increased, the time of exposure must be increased directly as the square of the distance; and unless intensifying screens are used, which is not recommended, the ensuing prolonged exposure borders on the depilating dose of roentgen ray. In order, therefore, that a shorter film target distance could be employed, the following method was adopted for the exact correction of distortion owing to ray divergence. A rigid brass bracket is attached to the vertical plate changer. On the arm of the bracket a slide is arranged, the under part of which holds a brass protractor. A monel-metal bob is suspended from the slide by means of braided silk (Johnson and Johnson surgical braided silk No. 8). The vertical plate changer is adjusted so that the bob hangs perfectly parallel to the plane of the plate changer. This is indicated by the marks on the dial of the slide. The metal bob is machined so that its overall length at room temperature is exactly fifty millimeters. A duplitized film, fourteen by seventeen inches, is loaded in an exposure folder and attached to the front of the vertical plate changer by the use of adhesive tape; or the usual casette loaded either with a plate or a film may be used in the plate changer. The subject is seated directly in front of the plate changer and the head turned to the right so as to procure a dextro-sinistral exposure. The head is placed firmly against the vertical plate changer, and, after adjusting it so that the median sagittal plane of the head is perfectly parallel to the plane of the plate changer, is strapped by the use of three-inch gauze bandage so as to assure secure immobilization. With the head in this position, the slide is moved so that the metal bob hangs in the plane of the median sagittal section of the head, and the exposure is made. The finished film will show a lateral view of the head and a reproduction of the bob. The bob will be increased in size according to the amount of angular divergence of the roentgen ray bundle; and since it is in the median plane of the head, every median measure of the cranium is also increased to an amount proportional to the increase in the length of the bob. The roentgenographic length of the bob is measured with a steel rule in millimeters, interpolating to half a millimeter. From the proportion between the length of the bob as it is measured on the roentgenogram, hereafter called roentgenographic length, and the known actual length (fifty millimeters), a co-efficient is established, which, applied to the roentgenographic measures of diameters in the median plane, gives the true values corrected for divergence. The calculation is expressed by the equation:

Actual length of bob (50 mm.) : Roentgenographic length of bob (50 plus mm.) : : X : Roentgenographic length of skull measures.

or,

$$X = \frac{50 \times \text{Roentgenographic length of skull measures}}{\text{Roentgenographic length of bob}}$$

The technique described is independent of the focus of the tube. Tubes supposedly of the same focus do not have the same constant of x-ray divergence; and, of course, tubes of different focus have quite different degrees of x-ray divergence; but by the method

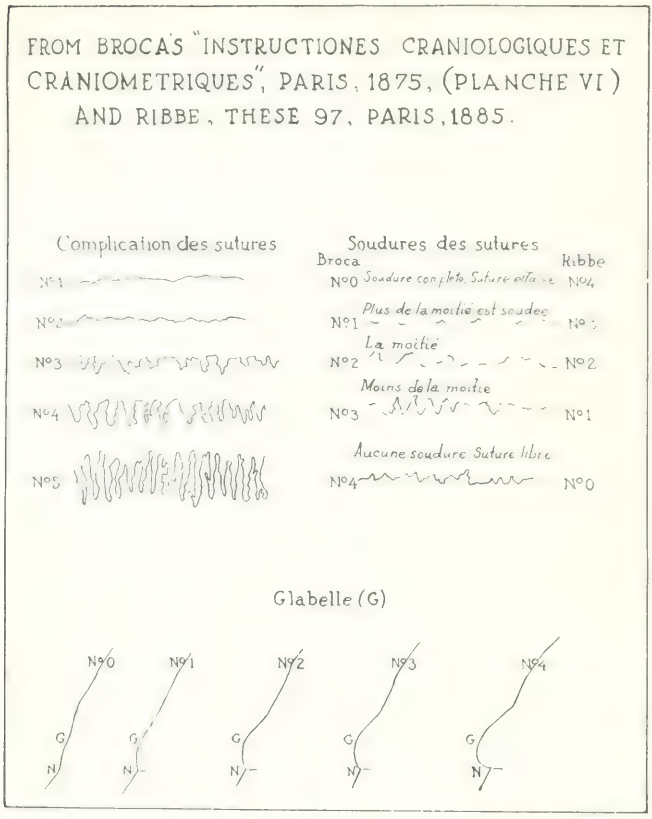

Figure I.

outlined, tubes may be used interchangeably without fear of reducing the accuracy of the subsequent measurements.

Torque-like winding of the bob is prevented by the use of braided silk. The vibration in the room produced either by a rotary converter or the motor of the rectifying disc may impart a barely perceptible swing to the hanging bob; but the purposely rounded ends of the bob, in swaying move radially and, therefore, do not cast any appreciable indistinctness on the roentgenogram; so that the error introduced from any gentle tremor of the bob during exposure is virtually indeterminate and needs no correction.

In order to expedite calculations, the x-ray divergence protractor may be used. This consists of a transparent celluloid plate upon which appear certain rulings. The protractor is placed on the film and moved until the bob falls within the upper and lower limits of the ruled area; and on the graduation nearest to that point appears the fraction or coefficient by which all sagittal measures of the skull must be multiplied in order to convert roentgenographic lengths to actual lengths. The rulings and graduations of the protractor are so spacious as to permit interpolating to the third decimal place; thus, if the roentgenographic length of the metal bob falls between the marks 0.78 and 0.79 on the protractor, one would use the factor 0.785 as the coefficient of correction.

In Fig. 2 a blueprint tracing of the divergence protractor is shown.

Position of the Subject

Right-handed individuals should be posed in the dextro-sinistral view, and contrariwise, left-handed individuals in the sinistro-dextral view. Anthropometric research establishes that the cranial vault is somewhat longer on the left than on the right side. This seems to result from the greater length of the left cerebral hemisphere in right-handed individuals. For this reason, since the greatest antero-posterior diameter of the skull is one of the measures sought, and in observance of the first cardinal principle of roentgenography [3] the right or left handedness of the subject must be established and the exposure so made as to present the clearest definition of the longest cranial half.

When sagitally rayed from one posture and a single exposure, the roentgenogram of the head can not be expected to show all of the cranial structures in their minutest detail. The lamboid suture is frequently readily visualized; the coronal suture may be seen sometimes in the younger subjects, but even in these it is usually imperfectly outlined. The central ray should be directed at a point one inch above and one inch in front of the external auditory meatus (as in the case for the exposure of the sella turcica).

Knox, in his book on radiography and radiotherapeutics, refers to the method described by Doctor Finzi and improved by Trevelyan George for securing a perfect alignment of the head when undertaking sagittal exposures.

> "A useful method for the radiography of the sella turcica has been described by Dr. Finzi. The patient is placed upon the

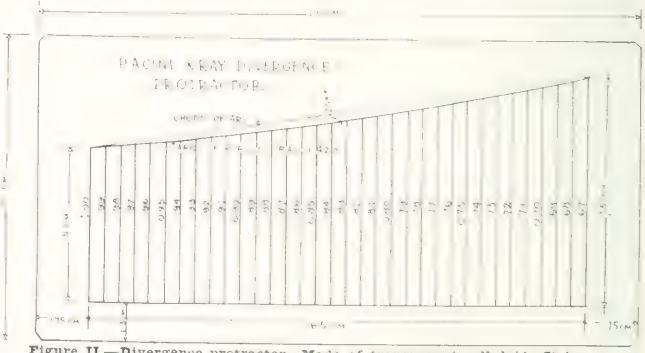

Figure II.—Divergence protractor. Made of transparent celluloid. It is applied over the film or plate to measure the roentgenographic length of the bob. The coefficient corresponding to the roentgenographic length is applied to all median sagittal measures, thus correcting the roentgenographic measures to true values.

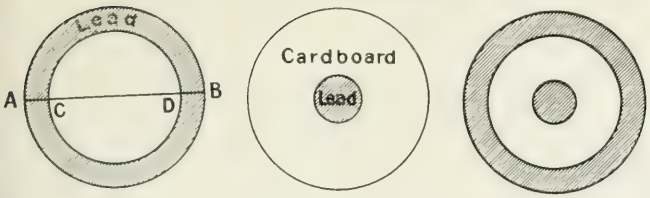

Figure III.

couch and the tube centred from below. To determine the exact position two small coins are placed one in each ear. After these are superimposed under the screen, the tube is then moved upward and forward one inch in each direction, and the radiograph taken. A perfect picture of the area required should be obtained.

"There is one objection, however, to this method, and this is the obvious one that the lower coin (assuming the tube to be beneath the table) will cast a larger shadow on the screen than the upper one, and therefore, as both coins are opaque, it is not possible to say when the smaller shadow is exactly in the centre of the lower one, as it should be if the view of the head is to be a strictly lateral one.

"To obviate this defect Trevelyan George has substituted a lead ring for the *lower* coin (again assuming the tube to be below the table). This is very simply made by describing two concentric circles on a piece of thick sheet lead and cutting away the superfluous metal. Exact measurements are not essential, as ears differ much in size, but a convenient size is obtained by making AB equal to twenty mm., and CD equal to fourteen mm. (See Fig 3), and a convenient thickness of sheet lead to use is one and one-half mm.

"Instead of the *upper* coin a circular lead disc. cut out of the same sheet of metal, is used, a suitable diameter being seven mm.

"Now, it is of the utmost importance that the two articles, the ring and the disc, be placed symmetrically in the auricles, and as they differ in external diameter, this raises a difficulty. In order to get over this, the diameter of the disc is artificially increased to that of the ring, that is, to AB, by embedding it in a circular hole of the proper size cut in a piece of cardboard of about the same thickness as that of the lead, and trimming the cardboard to the necessary size and shape. To keep the disc firmly in its place within the cardboard, two circular discs of thinner cardboard are cut with diameters equal to AB, and cemented with glue or seccotine, one on each side of the compound disc of lead and cardboard. The result is a disc which looks as if it were made entirely of cardboard, but which really contains the lead disc embedded in a central position in it. Wood or other partially transparent materials can of course be used instead of the cardboard. A coating of 'new skin' renders the disc waterproof, and it can then be washed after each case."

This method was used, but did not offer results differing from those obtained simply by judging the head to be in the median sagittal plane. It offers the disadvantage of casting confusing shadows of the lead ring and disc that interfere with the visualization of anthropometrically important anatomic structures, more especially the silhouette of the external auditory meatus. If there is any doubt in the mind of the investigator about his ability definitely to judge the head to be in the median sagittal plane, the nasion or glabella, and the menton may be marked with wax pencil on the skin of the subject; and with the subject facing the bob the head may be so aligned that the thread of the bob superimposes the marked points, when practically perfect median sagittal posture will be assured.

As will be discussed in that part of this study dealing with descriptive roentgen ray anthropology, certain relative values are adjudged by inspection. Thus, the relative size of the skulls is a factor useful in determining the sex formula. Any series of observations should, therefore, be conducted as nearly as possible under the same conditions in order that the relative comparisons may be on a similar basis. The enquirer should use the same tube throughout a whole series, or, in case of breakage, a tube of the same focus should be used in replacement. The film-target distance should be approximately identical for each consecutive exposure. The focus should in each case be directed at the site mentioned; that is, an inch above and one inch in front of the external auditory meatus. By maintaining these factors throughout, the resulting roentgenograms are relatively comparable in the evaluation of characteristics as will subsequently be described.

Exposure Factors

Much depends upon the current supplied to the high tension transformer. If the initial power is direct current, and must therefore be converted to alternating, despite the fact that the tested setting on the machine may give a spark gap and milliampere meter reading identical to that obtained with a machine initially supplied with alternating current, the finished roentgenograms are appreciably less distinct in the former instance; so that two sets of exposure factors are advised, one to be used when the initial supply is direct, and the second when the initial supply is alternating current. These factors represent averages suggested by Dr. I. Seth Hirsch, Dr. Frederick M. Law, Dr. Leon T. LeWald and Dr. W. W. Eldridge.

TABLE 1.

FACTORS OF EXPOSURE.

	When D.C. machine is used.	When A. C. machine is used.
Target-film distance--inches	30	30
Spark gap--inches	6	5
Milliamperes	30	30
Time in seconds for:		
Laterally thin heads	7	9
" medium heads	8	10
" thick heads	9	11

Others factors were used, varying the spark gap, or the milliamperes, or the distance, with corresponding compensation in the time of exposure; but no technique was found that would give better general results than the factors submitted. In the case of alternat-

ing current machines the factors are such as can be obtained by the average bedside unit equipped with a thirty milliampere radiator type Coolidge tube. In the case of the direct current machine a hospital type transformer may be used.

Dr. Willis F. Manges courteously tendered the following information relative to the factors of exposure: A six-inch gap he considers better than a five-inch spark gap for head work at thirty inches distance. The smallest possible diaphragm or cone should be used to eliminate scattered rays. The question of whether the film holder rests against a back of wood or metal is important. Scattered rays come back more easily through wood than through metal and are conducive to fogging the film. Doctor Manges also points to the choice of a proper developing solution and recommends the use of the latest published formula furnished by the Eastman Kodak Company. The formula submitted by the Eastman Kodak Company, thanks to Mr. Millard B. Hodgson of that company, is the following, for tank development:

	Metric
Elon	42 grams
E. K. Co. Sulphite of Soda	2040 grams
Hydrochinon	185 grams
E. K. Co. Carbonate of Soda	1020 grams
Potassium Bromide	36 grams
Water to	22 liters

Eastman exposure folders were in some cases lined with lead foil; or a sheet of lead, fourteen by seventeen inches, was placed behind the exposure holder. While this procedure usually made for greater accentuation of bone detail in many roentgenograms of parts other than heads, apparently through absorption of secondary rays, it was felt that no appreciable advantage obtained in the case of the skull. Perhaps the cranial contents in some way act to preclude finest detail through the use of lead as compared to the detail obtained without the use of lead. The use of the Potter-Bucky diaphragm was found unquestionably conducive to the production of excellent roentgenograms; but the results, for the purpose of this enquiry, were not thought to be better to a degree at all commensurate with, or warranted by the additional cost and impracticability of the technique, and it was, therefore, discarded.

In the photographic development of the film it was found better to choose over rather than under development. A developer which produces a minimum of fog is especially useful in securing contrast. Less contrast may be increased greatly by intensification with the usual mercuric bichloride solution. Each film should be identified with a lead number attached during the exposure, and at the earliest convenient moment there should be marked on the film in white drawing ink, the

Name
Age
Sex
Height
Weight
Physical condition
Clinical diagnosis

This serves not only for future identification, but it also completes the record and assists greatly in the subsequent study of the case.

Light Box

In a laboratory where roentgen ray anthropometry is to be extensively practiced, it will be convenient to provide a light box, the glass of which lies in a horizontal plane. It is sufficient to use one of the pair of stereoscopic light boxes rested in the proper position on a table, the height of which table will be governed by whether the roentgenologist prefers to sit or to stand during study. If a special light box is to be devised, average ingenuity will dictate the design. The only recommendation to offer is that the ground glass surface be somewhat larger than the usual stereoscopic light box size, say twenty-four by twenty-four inches; and that the lamps be deeply set and the box well ventilated to guard against undue overheating.

ACCESSORY INSTRUMENTS

For accurate mensuration of linear diameters a centimeter rule, graduated in millimeters, should be available. A convenient length is thirty centimeters; and a second shorter rule, say fifteen centimeters in length, will also prove useful. Those expressly made for this inquiry were of transparent celluloid, one and five-tenths centimeters wide, two-tenths centimeters thick. It is thought that transparent rules, by the fact that the point measured underlies the superimposed graduation, allow of an accuracy in reading greater than can be derived from the use of opaque rules, when the reading must be taken slightly aslant. Of whatever material constructed, it is fundamentally imperative that the graduations of the rule be of maximum accuracy.

In addition to the rules, a straight edge, about thirty-five or forty centimeters, should be provided as a guide for pencil marking the roentgenograms. The measuring rules should not be used as straight edges.

Dividers, about fifteen centimeters long, with extra pencil and ink attachments, are essential.

In addition to the instruments mentioned a small drawing set and ordinary drawing materials, including ink, hard and soft pencils, Bristol board, cross section paper, tracing cloth, celluloid goniometers and allied accessories, can be used, depending upon the form of record it is desired to obtain; but these miscellaneous appurtenances will be required only as the needs and enthusiasm of the enquirer may recommend.

SUMMARY OF APPARATUS AND INSTRUMENTS

The apparatus and instruments required in roentgen ray anthropometry may be classed into three groups, as follows:

1. Required
2. Essential
3. Accessory.

The required group comprises—

1. Any standard roentgen ray transformer, tube stand and tube.
2. Some form of vertical head rest, for which a stereoscopic plate changer will serve admirably.
3. Apparatus for the precision correction of distortion incident to roentgen ray divergence, including precision bob, bob sliding support and x-ray divergence protractor.
4. Accurate rules.

The essential group comprises—

1. Horiontal light box.
2. Dividers.
3. Goniometer.

The accessory group includes—

1. Drawing instruments.
2. Drawing materials.
3. Miscellaneous adjuvants.

Thus, it will be observed, the apparatus imperatively demanded for this study is neither excessive nor complicated. The accessories may be augmented at the will of the roentgenologist so as to include the most diversified assortment.

PRECISION AND SIMPLICITY

Unless precision and simplicity be at all times observed, the results accruing from whatever study become increasingly valueless and react to suppress or even eradicate any newly tendered science. In roentgen ray anthropometry, ordinary expertness in roentgenography is the first necessary qualification; and this can be met by any careful roentgenologist. The additional instruments, including the bob, bracket and protractor, admit of theoretically perfect results; and their construction and use is so simple that in this inquiry the degree of precision obtained depends entirely upon the amount of care expended. The instruments are originated so that only reasonable care is

TABLE II.

1. Test on white male skull.	2. Tube used (Coolidge)	3. A Focus	4. Approximate target-film distance Inches	5. (a) Protractor reading of bob	6. (b) Roentgenographic length of skull. Centimeters.	7. (a x b) Corrected length Centimeters	8. Measured length Centimeters	9. Difference
1	10 ma.	Fine	About 15	0.91	18.0	16.38	16.4	-.02
2	10 ma.	Fine	" 30	0.805	20.6	16.58	16.6	-.02
3	10 ma.	Fine	" 50	0.78	21.4	16.69	16.7	-.01
4	30 ma.	Fine	" 15	0.89	19.0	16.91	16.9	+.01
5	30 ma.	Fine	" 30	0.82	20.9	17.13	17.2	-.07
6	30 ma.	Fine	" 50	0.76	22.7	17.25	17.3	-.05
7	7 inch	Fine	" 20	0.865	20.1	17.38	17.4	-.02
8	7 inch	Fine	" 40	0.795	21.9	17.41	17.4	+.01
9	7 inch	Fine	" 60	0.73	23.9	17.42	17.5	-.08
10	7 inch	Medium	" 20	0.83	21.2	17.60	17.6	.00
11	7 inch	Medium	" 40	0.76	23.1	17.56	17.6	-.04
12	7 inch	Broad	" 20	0.805	22.2	17.87	17.9	-.03
13	7 inch	Broad	" 40	0.71	25.3	17.96	18.0	-.04

demanded in their use; and with reasonable care, the accuracy of the results yielded by roentgen ray anthropometry far surpasses that obtained in ordinary anthropometry, notwithstanding that in the latter the standards are exceptionally stringent, requiring a degree of skill that can be acquired only through persistent and prolonged practice.

To illustrate the degree of accuracy of which roentgen ray anthropometry is capable, various skulls were measured for their maximum length, or greatest antero-posterior diameter of the vault, according to the instructions of the International Agreement for the unification of craniometric and cephalometric measurements, as described by Hrdlicka in his textbook on anthropometry, using the Hrdlicka standard spreading compass *(compas d'epaisseur)*. These measures appear in column eight of Table II. The skulls were then roentgen rayed according to the technique described, using different Coolidge tubes for each exposure, as indicated in columns two and three, Table II; using roughly approximate target-film distances, as listed in column four, Table II. The purpose of the survey was to diversify the tube focus and target-film distance factors as much as possible. Column five gives the protractor reading of the roentgenographic silhouette of the precision bob. The reading, it will be noted, is expressed in two decimal places, and occasionally in three. Although the spacious markings permit of closer interpolation than half spaces, it is entirely unnecessary to attempt any more than whole numbers or whole numbers and halves. Column six shows the roentgenographical greatest length, antero-posteriorly, measured in centimeters and millimeters with a rule of tested accuracy. Column seven shows the corrected length obtained by multiplying the roentgenographic length by the protractor coefficient; that is, the products of columns five and six. In column nine the difference between the corrected roentgenographic length and the length as obtained on the skull by anthropometric measure, is expressed in fractions of a centimeter. It will be observed that in no instance, in this series, did the difference amount to one millimeter; although the experimental error permitted by anthropologists in the measure of the dry skull is two millimeters.

Table III is reproduced from Table II, and shows the roentgenographic length corrected and reported in terms of centimeters and tenths, as is prescribed in roentgen ray anthropometry. The rule is that when the second decimal place as obtained by calculation is five or more, the first decimal place is augmented by one unit; and when the second decimal place is less than five, the first decimal digit is used unchanged. By adopting this rule, columns seven and eight of Table II are reproduced as columns one and two of Table III, and it will be noticed that the corrected roentgenographic length of the skull in practically every case coincides with the actually measured; or, if it varies, the difference (in one case, one millimeter) is less than the allowable maximum recognied by anthropologists.

TABLE III.

1. (a x b) Roentgenographic Corrected length. Centimeters.	2. Measured length Centimeters.
16.4	16.4
16.6	16.6
16.7	16.7
16.9	16.9
17.1	17.2
17.3	17.3
17.4	17.4
17.4	17.4
17.4	17.4
17.6	17.6
17.6	17.6
17.9	17.9
18.0	18.0

Calculation

Errors in calculation may be divided into two classes, balanced and unbalanced. The balanced errors are those that result from personal factors; and the unbalanced errors, those that result from the use of improperly calibrated and incorrect instruments. Balanced errors are difficult to elimi-

nate, although they tend to become less and less as the roentgenologist develops increasingly greater skill in the enquiry. Unbalanced errors must be removed, or the results compensatingly corrected for them.

The numerical statement of a measure is accurate in proportion as it expresses the true value of the thing measured; and precise as it approaches an expression of the mean of a number of measures. Accuracy is, therefore, concerned only with balanced errors. It is possible for a numerical evaluation to be precise, yet at the same time erroneous.

The expressed reading should, therefore, be given in terms that are in keeping with the accuracy of the observation. In recording measures of length the results should be expressed in centimeters and tenths. Fractions of a millimeter convey a precision wholly beyond the accuracy of observation.

To obtain the various indices, and in the computation of roentgen ray anthropometric results generally, the simplest arithmetic is all that is required. One who is conversant with the "rule of three" is at once a master of the basis for calculation incident to roentgen ray anthropometry. [4] Several short cuts may be introduced such as the use of the slide rule, or a table of logarithms. These are left to the roentgenologist to choose, his previous extent of mathematical training serving as a guide. In conducting multiplications and divisions, certain short methods yield results sufficiently accurate for purposes of roentgen ray anthropometry. Thus, the operation of multiplication may be done in full as follows:

```
      16.45  (Multiplicand)
      12.93  (Multiplier)
      4935
    14805
     3290
   1645
  212.6985
```

In this calculation the 5 of 16.45 and the 3 of 12.93 are really useless figures that may be sacrificed without affecting the accuracy of the result. This multiplication may be abridged, as by the following method: Write the multiplicand. Reverse the order of the figures in the multiplier and write them directly below those of the multiplicand. Multiply as usual, excepting that the first (right-hand) figure of each partial product is obtained by multiplying the figure of the multiplicand by the one directly below it in the multiplier, mentally adding anything which should be carried from the multiplication of the preceding figure of the multiplicand by this figure of the multiplier. Writing these partial products so that their right hand figures stand in a vertical column, they may then be added and the decimal point determined by inspection. Thus:

```
 16.45  (Multiplicand)
 39.21  (Multiplier, reversed)
1645
 329
 148
   4
212.6
```

In order that this method may be better explained the example is again worked out as follows:

```
  16.45
  39.21
 ------
1645 |
 329 |0
 148 |05
   4 |935
 ------
212.6 |xxx
```

Those figures that are to the right of the vertical line are omitted in the written calculation and simply mentally conducted.

In a similar manner a corresponding abridgment of long division may be effected by deleting a figure of the divisor in each partial division after the first instead of bringing down a cipher. For example:

```
16.45) 2126 (12.93
       1645
        481
        329
        152
        148
          4
          4
```

This same division is worked out in full, showing the mental calculations that are eliminated, the figures to the right of the vertical line being the ones deleted:

```
16.45) 2126 (12.93
       1645
        481
        3290
        152
        14805
           4
           4935
```

The short methods indicated are not necessarily prescribed. They are offered only for the convenience of the investigator.

Having discussed the apparatus necessary in the technique of the investigation; introduced a method for correctly evaluating from the roentgenogram the true anatomic measure of the structures that appear projected upon it; presented the procedure necessary for the roentgen ray anthropometric study of the skull, and its accuracy clearly demonstrated; and discussed the mathematics of the investigation, there will now be submitted a system of roentgen ray anthropometry.

Method of Investigation

Just as physical anthropology and anthropometry are essentially concerned with the study of man's variation, dealing in a comparative way with the study of the human body and its inseparable functions, so, too, is roentgen ray anthropology and anthropometry interested in establishing the comparative element in relation to general human anatomy and physiology, and general biology. Therefore, the method of study in roentgen ray anthropometry must be similar to that adopted by the physical anthropologist. The investigation should be conducted upon the unit of "a series" of cases; the anthropometric data derived from a single case being infinitely less valuable than that derived from a large number of cases.

The roentgen ray anthropometrist having practiced the accredited roentgen ray anthropometric methods and acquired the necessary degree of accuracy is next concerned with the collection of roentgen ray anthropometric material. Proper blanks should, therefore be provided upon which may be catalogued the necessary information and identification of the roentgenograms to be studied. The forms of these blanks are compiled to meet the needs of each roentgen ray anthropometrist. In their proper place replicas of the forms elaborated in connection with their original survey will be included for guides to those who may desire to begin or to continue roentgen ray anthropometric studies.

Before the roentgen ray anthropometrist proceeds in this study it is necessary that he should first qualify in general anthropological literature. By acquiring a knowledge of general anthropology and anthropometry many of the discussions to be presented in this thesis will be more lucid and lucent to the reader; so that a proper introduction to the study should include at least a reading knowledge of Darwin's "Descent of Man," "Origin of Species" and "Variation of Animals and Plants under Domestication"; Vernon's "Variation in Animals and Plants"; Haeckel's "The Evolution of Man"; Marett's "Anthropology"; E. B. Tylor's "Anthropology"; de

Quatrefages' "The Human Species"; Topinard's "Elements D'Anthropologie Generale"; Hrdlicka's "Physical Anthropology", and by the same author "Anthropometry." The references mentioned are only some of the innumerable important anthropological treatises; but a familiarity with these few will serve as an excellent foundation in the light of which roentgen ray anthropometry may be intelligently appreciated and applied.

FOOTNOTES

1—Under the directions of the Smithsonian Institute.

2—Figures 207 and 208, page 149.

3—The part to be rayed must be placed as nearly as possible against the plate or film.

4—"Rule of Three":—2 : 4 :: 6 : x. Simple proportion.

To be Continued in the July Journal

ROENTGEN RAY ANTHROPOLOGY
(Sex Character of the Cranium)

NO. 1

CHARACTERISTIC	Value					
SIZE:						
very small	1					
small	2					
intermediate	3					
large	4					
very large	5					
SMOOTHNESS:						
very smooth	1					
smooth	2					
intermediate	3					
rough	4					
very rough	5					
SUPRA-ORBITAL RIDGES:						
trace	1					
slight	2					
moderate	3					
medium	4					
pronounced	5					
excessive	6					
MASTOID PROCESS:						
small	1					
moderate	2					
medium	3					
large	4					
excessive	5					
ZYGOMATA:						
slender	1					
moderate	2					
medium	3					
strong	4					
massive	5					
LOWER JAW:						
very obtuse	1					
obtuse	2					
intermediate	3					
acute	4					
very acute	5					
LOWER JAW:						
very low	1					
low	2					
intermediate	3					
high	4					
very high	5					
Total sum of character values						
Name						
Age						
Sex						
Height						
Weight						
Physical condition						
Clinical Diagnosis						

NO. 2

ROENTGEN RAY ANTHROPOMETRY
(Measures)

(Data according to prescribed Roentgen Ray Anthropometric Standard)

MEASURE					
1. Maximum length of skull. (glabella to occiput)					
2. Maximum internal length. (supra-anticlabella to endo-occiput)					
3. Akoustio-bregmatic height. (akoustion to bregma)					
4. Akoustio-endobregmatic height (akoustion to endobregma)					
5. Naso-menton diameter. (nasion to menton)					
6. Naso-alveolar diameter. (nasion to alveolar point)					
7. Facial depth.					
Identification number					
Name					
Age					
Sex					

Note: The values recorded are uncorrected for Roentgen-Ray divergence. To correct apply protractor reading of bulb, which is _____.

NO. 3

ROENTGEN RAY ANTHROPOMETRY

(Indices)

INDEX					
1. Endocranial module; (sum of supra-anticlabella and 1/3 twice akoustio-endobregmatic diameters					
2. Facial angle; Included between naso-alveolar and akoustic-alveolar lines.					
3. Sphenoidal angle; Included between naso-turcicon and turcico-akoustion lines.					
4. Height index; $\frac{\text{akoustic-bregmatic} \times 100}{\text{maximum length}}$					
5. Cranio-facial index; $\frac{\text{naso-menton plus facial depth} \times 100}{\text{maximum length plus akoustio-bregmatic}}$					
6. Jaw-face index; $\frac{\text{naso-alveolar} \times 100}{\text{naso-menton diameter}}$					
Identification number					
Name					
Age					
Sex					

Standardization of Dosage Factors*

H. J. ULLMANN, M. D.
Santa Barbara, Calif.

WHEN visiting the average laboratory one cannot help noticing the carelessness and inaccuracy with which the factors governing roentgen ray dosage are measured and recorded. One operator will take the reading of a so-called spark gap meter which is simply a voltmeter on the primary circuit, and record it as the gap used without at the same time stating what rheostat setting was used. He probably never realizes that the reading represents a different gap for nearly every setting, and also varies with the milliamperage flowing through the line. Another will set his gap, which may consist of anything from a fairly sharp point to one so blunt that it is nearly a small sphere so far as the action on the spark is concerned, and then change from setting to setting until a spark occurs. Another may not be satisfied until he has a flame between the points. Still another will make a setting and then, with the machine running, pull or push the points together until a spark jumps, recording that distance as the gap. Another will use a setting which at some time in the distant past gave a spark of a certain length without realizing that a given setting may result in different voltages under varying conditions of load, primary line voltage, etc. These varying methods of estimating gap effect the relationship of gap to actual voltage profoundly and yet every one of these operators will feel that he is using a definite standard. When he has established his gap the operator will then set his filament control so that the milliammeter is reading a certain load to his satisfaction and that amount is recorded. If his meter is showing five, and one asks what the tube is carrying, he will look surprised and reply, "Why, five, of course." And yet, if the tube is disconnected and the switch closed the meter may read anywhere from a tenth of a milliampere to two milliamperes depending on the voltage, and this amount must be deducted from the reading with the tube in circuit before the actual amount producing radiation can be estimated. Is it not possible that much of the variation in effects found by different workers supposedly using equal dosage factors is due to actual variations in the factors themselves, that is, inaccurate measurement or differences in nomenclature?

Let us first consider what these factors are and then take up the question of measurement separately for each factor. All of these factors are not subject to serious error in practice and the discussion is limited to such as are. For this discussion only the physical factors will be considered since the biological factors, such as skin reaction, radiation sickness, effects on the blood and other tissues, cannot be accurately determined until the physical factors are definitely established. Unfortunately, much of the work on the reaction of tissue to radiation has been done with poorly controlled physical measurements and there are experiments described which would be impossible to duplicate from the data given. It is doubted if the experimenters themselves could exactly reproduce the conditions described by them.

The physical factors involved in applying a given quality and quantity of radiation to a given amount of tissue are: For quality, *first*, the voltage applied and maintained at the tube terminals; *second*, the filtering material and its amount placed between the source of radiation and the irradiated object. For quantity, *first*, the voltage applied and maintained at the tube terminals; *second*, the volume or rate of current flow through the tube; *third*, the time during which this rate of flow is maintained; *fourth*, the distance between the source of radiation, the focal spot, and the substance being irradated; *fifth*, the size of the area being irradiated; *sixth*, the filtering material and its amount between the source and the object irradiated.

Of all these factors the one of the two affecting both quality and quantity —the voltage—is the most carelessly measured. It is not only carelessly measured, but there are two meanings for the same term voltage as used in roentgenotherapeutic literature today. To make matters worse, another method of estimating and recording quality of radiation is usually used, in fact it is the oldest method and has the authority of age. This method is that of the parallel spark gap and is generally recorded as "gap" without qualification as to what kind of a gap is meant. Lately it has been customary to add "between blunt points" to the word "gap." How blunt these points are or how the gap was tested, that is, by meter reading, by setting and testing or by moving the gap while the tube was running, is left to the imagination. About two years ago the writer, in order to find out just how great the error was in estimating voltage by these methods, tested a number of machines with a standard gap, the method adopted by the American Institute of Electrical Engineers for measuring high voltages. The results were startling. A variation from thirty-two per cent above the supposed voltage to twenty-four per cent below was found. Six machines were tested. The results and conclusions were published in the *American Journal of Roentgenology* for April, 1921. As the method and the comparison of accuracy between the sphere and point gaps were covered in that paper they will not be repeated here. Since that time other machines have been tested in Chicago, Los Angeles and Santa Barbara, California. This supplementary data only emphasizes the contention that the use of the point gap, spark meter or voltmeter on the primary as usually used to measure the voltage at the tube is grossly inaccurate. The following table was compiled from some of the observations made on different machines, both in Chicago and Los Angeles.

The figures above the line in each case represent the gap in inches between blunt points, or those which were recorded by the operator as such, and the figures immediately beneath are the peak or maximum kilovolts as measured at the tube terminals with a standard sphere gap. The different figures are the result of observations made on different machines.

6-inch	6¾-inch	8-inch	9-inch
83		110	120
85	85	120	124
90		131	124
92		131	125
99			127
			127

It is easily seen from these figures that one attempting to regulate his dosage by the old gap method might give an overdose as high as thirty-seven per cent or as much as fourteen per cent lower than he intended when using a six inches gap, with an eight inch gap from twenty per cent over to six per cent under and with a nine inch six per cent variation in either direction.

Unfortunately, if we agreed to use the definite term voltage instead of the ambiguous spark gap in defining this

*—Read at the Annual Meeting of The Radiological Society of North American, Chicago, Dec. 2, 1921.

particular dosage factor we would still cause confusion unless we stated whether the kilovolts were the peak or maximum or whether the effective or root-mean-square voltage was meant. The writer, within the last few months, has heard one essayist state that he was using a certain gap which represented so many kilovolts and a few minutes later another make the equally positive statement that the same gap represented a voltage nearly one and a half times as much. A little calculation showed that they both were using the same voltage factor, but were giving different meanings to the term kilovolts. One meant by kilovolts the effective, the other the peak or maximum. If the first had said that he was using one hundred kv. effective and the other one hundred and forty kv. peak there could have been no misunderstanding.

When the first reports of the German technique were published in this country one often heard that they were using one hundred and forty to one hundred and fifty thousand volts while our best was about one hundred thousand. It was soon shown, however, that their one hundred and forty was equal to our one hundred, because we were in the habit of using the effective voltage term while they used the peak. At this point it may well be asked what the essential difference is and why either rating cannot be used provided it is followed by the qualifying adjective "effective" or "peak"? There are two good reasons of which the second is the most important. First—where two terms are used interchangeably for the same thing, each requiring a qualifying adjective, that adjective will be frequently used with resulting confusion as to just what the author meant. The second and most important reason requires a little discussion. It has been established that the composition of the ray bundle from a tube excited by a pulsating or alternating current is dependent on the maximum or peak voltage reached at each current pulsation, other factors being equal. Therefore, it is essential to know for purposes of comparison or standardization, the maximum or peak voltage applied and maintained at the tube terminals. The distance a spark will jump between points or spheres, all other factors being equal, is dependent on this maximum voltage. The peak voltage is, therefore, the voltage measured by a spark gap. In engineering practice a gap may be calibrated for effective voltage, as the effective or root-mean-square voltage is that generally used by engineers. Engineers assume that power line alterations are in the form of pure sine waves, in which case the relationship of the effective to the peak voltage is a constant—1 to 1.414. The engineer needs to know the effective or average voltage because the power developed in electrical machinery depends on this value, and not on the peak. The value of insulation, however, depends on the peak voltage. We may be receiving a pure sine wave in the primary of our transformer, but what is it after stepping up and rectification? Suppose we are getting such a wave, the relation is then 1 to 1.414, but suppose that instead of a pure sine wave leaving the transformer it is a semi-ellipse, the ratio then becomes 1 to 1.22, if an inverse sine 1 to 2.10, or if an inverse ellipse 1 to 3.23. If the wave is from an induction coil or contains harmonics the ratio will vary still more. If we measure the effective voltage by means of an electrostatic voltmeter or a meter on the primary and record it as being one hundred kilovolts effective in the report of a certain treatment the following errors in duplicating the dosage by another operator may result. Assume that the other operator wishes to use the same voltage and is to use a spark gap, which measures the peak, as his measuring instrument. Let us also assume that it is calibrated in effective kilovolts. If both transformers deliver a pure sine wave he will be using the same voltage as the first operator. If the first operator's machine while receiving such a wave at the primary was delivering an inverse sine wave at the tube he was actually applying two hundred and ten thousand peak volts at the tube terminals. If the second machine was delivering a sine wave the second operator would be applying one hundred and forty-one thousand four hundred peak volts at the tube terminals although both would record the voltage or gap as the same. These comparisons could be carried on indefinitely for every imaginable combination of conditions. Why, then, if the sphere gap measures the peak or maximum voltage and has been accepted as the most accurate practicable method of high voltage measurement by the American Institute of Electrical Engineers, and as the average quality of the ray bundle from an x-ray tube depends on the peak voltage, should we use any other term than the maximum or peak voltage when recording the E. M. F. in our records? It would be a great step in the standardization of dosage and the correlation of results obtained in different laboratories if the voltage factor were always measured by a standard, accurate method and recorded as kvp.—kilovolts peak, and the inaccurate "inches gap" never mentioned.

The second factor affecting both the quality and quantity of radiation—the filter—will only be taken up briefly, as it has been thoroughly discussed in the literature during the past year. There is one point, however, that seems to be seldom considered, the scattering factor. For example, it has been stated that X mm. of Cu is the equal in filtering power of 18 mm. of Al. This statement is based on the assumption that these respective thicknesses will stop A per cent of all waves longer than N Å. Assuming this to be the case and a wave of such length be used that ninety-five per cent is absorbed by X mm. of Cu and that this thickness be such that, for purposes of comparison, the scattering is negligible, it may then be assumed that five per cent of the total radiation will reach the patient. Suppose that 18 X mm. of Al be substituted for the Cu. While the scattering per unit of thickness of Al is less than that of Cu the great difference in thickness of the Al will result in so much scattering that little or none of the five per cent which would be passed if there were no scattering will reach its object. From this it will be seen that the greater the density of the filtering material the more efficient it becomes because of the lessened thickness required to obtain the desired filtration. Provided that the density is within that limit which gives proportionly greater absorption of the long wave lengths. It is therefore dangerous to assume that, because an operator reports an hour treatment through ten mm. of Al that the same time can be given when the filter consists of 0.5 mm. of Cu and one mm. of Al. In the second case the patient, while getting roughly the same quality, is actually getting a greater quantity of radiation.

The first factor affecting quantity is the voltage, and has been discussed in the preceding paragraphs. The second—volume or rate of current flow—may seem to require little discussion, as its method of measurement has always been the same. It is desired, however, to call attention to serious sources of error, one of which was mentioned in the opening paragraphs. There are in practice two definite sources of error. First—Error in meter calibration; and second, leakage in the high tension circuit. If these possibilities are recognied they may be easily guarded against and remedied. Any meter may, after a varying time (and it usually does) change its reading for a given load. A change of forty per cent may be met with and smaller percentages are common. To guard against these meter changes it is only necessary to have three meters, one in reserve and two in the high tension circuit. It is

mann if he had had experience with osteomyelitis.

assured, of course, that only the highest grade of meter is under consideration. When the two meters in the circuit cease to read exactly alike the reserve meter is put into the circuit and the meter failing to check with the new meter is returned to the maker for adjustment and recalibration. Leakage in the line may be detected in two ways, by closing the switch with the filament current off and noticing the meter reading, or by cutting a meter in at one tube terminal and noting the difference between the reading there and at the machine. The leakage known for any given voltage, the current can be increased proportionally until the tube is passing the amount desired. For example: If the loss by leakage is found to be one milliampere the reading must be six to have five milliamperes passing through the tube.

The writer has been quoted as suggesting or advocating a sphere gap as a standard in voltage measurement. This is a misunderstanding. The suggestion was that a definite unit for recording the potential be adopted, a unit which has been standardized and about which there can be no misunderstanding in regard to the meaning. That unit is the volt and its multiple the kilovolt. The decision regarding the best method of measuring the voltage must be left to the physicists and electrical engineers. The sphere gap was used in making the tests described because it has been adopted by engineers as the most practicable method for measuring the peak value of high voltages in use today and also has the advantage of being an accepted standard.

The writer wishes to emphasize the necessity that a sphere gap must not be simply two spheres held by supports, one of which is movable, set on an ornate base with various tables of calibration, but must comply, in its every dimension and detail of construction to the standardization rules of the American Institute of Electrical Engineers. If it does not it will not measure voltage any better than the old, so-called point gap.

Conclusions

1. That the methods commonly used in practice to measure the physical factors of an x-ray dose are grossly inaccurate.

2. That much or most of the work being done on the biological effect of radiation is either valueless or must be repeated with properly controlled physical measurements before differing results can be correlated. This applies even more strongly to clinical observations.

3. That many variations in effects reported by different observers would probably cease to exist if their physical factors, within reasonable limits, were the same.

4. That when roentgenologists realize these facts and adopt uniform methods of measuring and recording, the records and observations will increase in value in proportion to their uniformity, and when sufficient accurate data has accumulated it will be found that many of the discrepancies reported by different workers will cease to exist.

Discussion

Dr. E. C. Ernst *(St. Louis, Mo.)*: I believe all of us will feel there are many things to be taken care of in giving the ordinary therapy doses. If we have learned nothing else, perhaps when we go back we will make every effort to follow all of these doses. It is unnecessary for us to be physicists to do so.

Of course, to be absolutely certain of what we are doing, the sphere gap is very essential. Just the small details are necessary in order to really give the lethal dose to the deeper tissue. For example, in the last six weeks I saw two radiologists working and copying one of the famous European techniques and they were using one hour, and one hour and a quarter exposures, using a millimeter of copper. In one instance they were using a distance of fifty centimeters and one of seventy-five. What were they getting beneath the tissues? Perhaps one-twentieth of the normal dose. Those are important things if we are going to follow and really produce the radiation within the deeper structures.

A number of the members asked me to again repeat a method of protecting the patient. The time was too short yesterday to bring that out. I have been following a simple method of using a switch. (I believe the description was published in The Journal of Radiology) a simple knife switch in the radiological room, having a large handle. To this knife switch is attached a string. This string is attached to the finger of the patient, tied around the forefinger. I sometimes use a thimble. The object of this switch is to turn off the primary circuit.

The patient cannot turn the hand without pulling the switch. You can blow on top of the wood extension and open it. Just the slightest pull opens it. The slightest move of the patient pulls the switch, turns off all of the current. I do not know of anything that will effect it mechanically. The patient cannot make much of a movement, cannot scratch her head or anything to get in close proximity to one of those wires unless she pulls that switch.

EDITORIAL

The JOURNAL OF RADIOLOGY

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Dr. Heber Robarts and Radiology

WHEN news of Dr. Heber Robarts' death was received, a very positive and clear succession of ideas was set in motion. Dr. Robarts, it will be remembered, was one of the charter and conspicuous members of the Radiological Society of North America and the American Roentgen Ray Society—conspicuous, not so much for his words as for his deeds. And now that his life has become his tribute to the science of radiology, the thought cannot be denied that there is a definite obligation on the part of each member of this and every other organization professing interest in the science, an obligation to actually do something tangible toward the prevention of such catastrophic sacrifice by men seriously attacking some of the imperious problems of radiology.

It is not for the purpose of memorializing Dr. Heber Robarts that these lines are written. His is a living memorial of deeds. Far better testimonial than anything which might be devised of the flimsy words which constitute human speech are his achievements in, and devotion to the science which finally snuffed out his life and ended many years of suffering borne with unexampled fortitude.

Dr. Robarts caught the vision of the science of radiology while it was in its infancy. He personified his belief in its potentialities by following and enlarging that science steadfastly until the day of his demise. And it is one of life's mockeries that this stalwart man should be stricken just at the moment when the child of his dreams is passing through adolescence. This is especially unfortunate because Dr. Robarts perceived very keenly those latent powers which all thoughtful Radiologists see limned on the horizon of this therapeutic agent.

Mindful of the price Dr. Robarts has paid, and paid gladly in order that suffering humanity might find alleviation for some of its direst ills, it is perhaps fitting something be said concerning the obligation each and every member of the Radiological Society, and every other person who professes more than a playful interest in the science of radiology, should assume fearlessly and without cavil in an effort to co-ordinate and correlate scientific research in the United States insofar as it has any bearing on this field of endeavor.

It hardly seems possible, however, that serious practitioners of radiology, especially those working on the therapeutic side, whether in a desultory fashion or serious way, will question the fact that the greatest achievement which must be accomplished before that science can demand the complete respect of intelligent men, is the correlation and co-ordination of the clinical and physical problems involved in its application as a curative power.

The therapeutic value of any science is the acid test by which it is gauged as either a medical or social agent. As things now stand, radiological practitioners must attempt to meet the clinical requirements of their practice with a very limited, and at best, poorly formed knowledge of the physical factors involved. The average practicing radiologist knows comparatively nothing about the physical side of the science he employs—yet the fundamental laws of physics are unquestionably important factors whose intelligent conception and use determine the character of therapeutic possibilities in either experimental or applied radiology.

Perhaps this abstraction merits some detailed consideration for the benefit of the reader who has not thought about this matter seriously, or who has been unable to reach a satisfactory and safe conclusion with respect to the failures registered altogether too frequently for comfort. Much confusion on the subject has resulted through an empirical medical training received before the science of radiology was known at all, or at a time when that science was looked upon as nothing more than a new phase of photographic art.

Make no mistake. No brief is held for the view that a thorough knowledge of physics is all that is required to fit a man for the intelligent practice of radiology. Nor is it contended for a single instant that a more or less complete knowledge of medicine with due cognizance of its clinical aspects is all one needs. Rather, the thought which is sought to be established beyond the point of controversy is, that the science of radiology embraces both sciences—medicine and physics—and that the former provides the yard-stick by which the latter must measure its achievements insofar as therapeutic values are concerned.

Emphasis is sought, also, to be placed on the fact that the study of physics has been, and still is, in very large degree, conducted by our institutions of higher learning along engineering and industrial lines rather than medical or therapeutic lines. And it must be conceded by every fair-minded person that a wholly different field is involved in the former than in the latter.

From all of which it would seem but the part of common sense to say, that if the physical problems which at present demand solution before the science of radiology can move on to its next development therapeutically, are ever to be approached and studied through with advantage, either to the medical profession or to the physicists of the world interested in human welfare, those medical men most interested in their solution must bring to the research worker in the purely physical field a clear and concise conception of the clinical phases of each problem to be attacked.

Because the clinician and the physicist have met on common ground, each with an open mind and a definite realization of the fact that alone he could never bring to his science the utmost in achievement, is the reason why radiology in Germany has for many years drawn hundreds of America's foremost practitioners to that country for observation, for study, and for instruction. Stated baldly, the correlation and co-ordination of their research work, with its acknowledged results, has been the lodestone by which the German scientists have commanded the admiration and blind hero-worship of American medical men.

This statement is not made with any thought of aspersion. Quite the contrary. It must be agreed that it is im-

possible to admit the fact which has just been acknowledged, a fact medical men have conceded by frequent excursions to Germany, without paying some deference to the vision and scientific acumen which has actually made all German scientists co-laborers with a common purpose and common objective, the public health.

In passing, it seems only fair to say that American scientists have enjoyed equal if not superior opportunity. This is exemplified by the fact that an American, W. D. Coolidge, conceived and perfected the tube which bears his name and which made possible the practical and beneficent application of x-rays. Without that tube, or some adaptation of the principles it applies, the development of radiology in Germany, or any other country for that matter, could never have reached its present state of eminence.

All which leads unmistakably to the conclusion that the medical profession of America, especially that part of it engaged in the science of radiology, has been inexcusably derelict in the performance of a duty which could not be performed by any other class or creed. That is a pretty harsh statement, and one which will undoubtedly incite a good many heated arguments. There is nothing quite so discomfiting and given to the breeding of distemper as the pointing out of one's sins, whether of omission or commission. But the fact remains. No honest man will deny it. He will, however, if he believes in himself and in his science, set about to fill the hiatus.

That brings us back again to such men as Dr. Robarts. That was the self-imposed job undertaken by him. That same job has been undertaken by other great and self-sacrificing men, and they, too, with him, have paid life tribute. Doubtless other zealous souls will pay a similar price for their ambitious scientific endeavors before the science of radiology is firmly established on an intelligent and scholarly basis, where the combined wisdom of all the sciences of which it is the culmination is applied in safeguarding the lives of its devotees, and in developing its therapeutic applicability to the ultimate.

conducted by our institutions of higher learning along engineering and industrial lines rather than medical or therapeutic ium, an armamentarium which contains greater unknown potentialities than that of any other curative agent, radiologists themselves are so certain of the future of their science that they have invested and continue to invest, sums of money ranging from $25,000 to $75,000 in laboratory apparatus and equipment and incalculable time and energy. That, too, without knowing, or having set in motion such orderly procedure as gives assurance they will some day know, how to apply that science intelligently and use such large investments efficiently. Is it disrespectful or unscientific, or even unprofessional, to suggest that such a situation presents something of an ironical exposition of Patrick Henry's famous edict "Millions for defense, but not one cent for tribute?"

Many other thoughts surge through one's mind in the serious contemplation of this condition. However they are in large measure merely incidental phases of the one outstanding proposition that the science of Radiology can never answer fully the demands made upon it by suffering humanity, and radiologists themselves can never attain a state of professional respectability and public confidence, until the job of co-ordinating and correlating the clinical and physical phases of the science has been seriously undertaken.

That is why the members of the Radiological Society should constantly find in the chair so lately made vacant by Dr. Robarts' death, that mute evidence of sacrifice, scientific devotion and incomparable fealty which should stimulate them to great achievement and constructive purpose, and in comparison, render a money contribution to a perpetual working organization designed to supply the fundamental requirements indicated, seem like a paltry thing indeed.

His Life His Tribute

NO less in the field of science than in the field of religion is it true—and in no mystic sense in either one—that the blood of the martyrs is the seed of life more abundant, making the desert blossom with beauty where before was hideousness.

Of none of these martyrs is it more true that dying they yet live than of those who have literally given their lives in searching out the laws of the science of radiology.

Dr. Heber Robarts, charter member of the American Roentgen Ray Society, and upon whom the Radiological Society of North America conferred the honorary degree in 1919, is the most recent one of those whose tragic yet sublime death causes us to lift our heads once more in thrilled admiration, and then to quickly bow them in awed realization of the grandeur of his living and dying.

More than twenty years ago Dr. Robarts began experimenting with radioactive substances and was one of the first men to make use of radiotherapy, when the path along which he traveled was yet dark. In groping his way along to the present early morning light he sacrificed first, the middle finger of the left hand, then the index finger of that hand, and a few years later the same fingers of the other hand.

After the last operation a cancerous condition developed in the right arm, finally metastasizing into the shoulder and chest, and terminating in his very recent death.

As soon after this last amputation as his condition became apparent, he went to a New York hospital, and later to Baltimore for treatment, where he found that his own methods were the ones in use. Returning home, he put himself into the hands of his own confreres, directing their handling of his case and being treated with his own radium.

Three weeks before his death he decided that the end was not far distant. He gave his final instructions regarding his personal affairs, and, true to his burning zeal for his profession, directed that a postmortem be held in the interests of science. To mitigate his great suffering he prescribed sedatives for himself, remaining in a conscious condition, however, until half an hour before he quietly slipped away.

Dr. Robarts was born at Godfrey, Ill., seventy years ago. He received his training at McKendree College, Illinois University, and had taken post-graduate work in the east and abroad. He practiced in St. Louis until 1904, when he removed to Belleville, Ill.

He was president of the Southern Illinois Medical Association, a member of the Roentgen Society of London, of the American Medical Association, the St. Louis Academy of Sciences, the St. Louis Medical Society and the Missouri Medical Society, as well as a member of the American Roentgen Ray Society and the Radiological Society of North America.

Canadian Consultation Bureau

The Canadian Radiological Society begs to announce to the profession of Canada that the society has established a consultation bureau, where any and all questions pertaining to x-ray and radium may be submitted for information, suggestions or advice.

One of the chief objects of the society is the maintaining of a thoroughly ethical standard throughout Canada in this special branch of medicine, and providing practical assistance toward that end. This is being done cheerfully and entirely without charge, and in doing so it is, of course, obvious that there is no mercenary motive whatsoever. The idea underlying the establishment of this bureau is that the members of the society, being specialists in this branch, are best able to assist in these matters. So, therefore, whether it be the selection of apparatus, difficulties in operation, or other points of a technical nature or otherwise, the resources of the society are being offered for the asking.

It is hoped that the profession will accept this offer as it is meant, and we assure you that we will be very glad to be allowed to assist you in this way.

Fraternally yours,
L. K. POYNTZ, Secretary-Treasurer.

Canadian Radiological Society

The third annual convention of the Canadian Radiological Society is being held in conjunction with the meeting of the Dominion Medical Association in Winnipeg, June 20, 21, 22, and 23, and I am instructed by the president to extend to the officers and members of the Radiological Society of North America a sincerely cordial invitation to be present at that time.

At our last convention we were honored by the presence of a very respresentative body of distinguished members of your society, and we will look forward to welcoming them and others at the Winnipeg meeting.

It is requested that those gentlemen who contemplate attending the convention communicate with the secretary at their earliest convenience.

L. K. POYNTZ, Secretary-Treasurer.

The cordiality shown in the above announcement is only a slight indication of what will be experienced by those who can attend the meeting. Our brothers across the border to the north have shown such loyal and enthusiastic support of all progressive efforts in radiology that we of the states owe them a debt which can never be paid. We can show our appreciation in a small way by attending the annual meeting of the Canadian Radiological Society at Winnipeg, June 20-23. Plan now to go. Combine this trip with your vacation if you wish.

Radium Theft

It may be of some interest to the readers of this Journal, especially to those interested in radium, to know that we have recently lost fifty-five milligrams of radium (four needles and one five milligram plaque) through theft. It was taken from a locked, combination safe. Fifty milligrams in two tubes in an applicator were overlooked by the thief, which probably points to his ignorance of radium. It is possible that this thief may apply to some physician for treatment of a radium burn and so be apprehended. Certain evidence connected with the theft seems to point to an organized gang of radium thieves going about the country.

ALBERT M. COLE, M. D., Indianapolis, Ind.

DEPARTMENT of TECHNIQUE

Nichols' Therapy Table

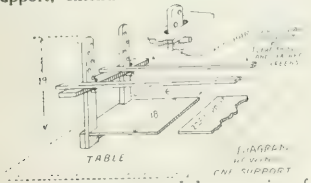
THE table here illustrated was designed after many attempts to secure a practical table for the administration of x-ray therapy. This table has now been used by the Cleveland Clinic for one year and has been found very satisfactory. Visiting men have so frequently expressed a desire for a cut of the table, with its dimensions, in order that they might provide themselves with one of similar type, that we have felt detailed directions would be of interest to many members of The Radiological Society of North America.

The table is constructed of wood, with leather and canvas strips for the support of the padded top. The distance from the floor to the leather top is twenty-four inches. The top is thirty inches in width and six feet long. At each corner is a solid wood post, thirty-eight inches high, tapering to a two-inch square at the top. On the outer side of each of these posts are three notches, the first two inches from the top of the post and the others at two inch intervals below. By means of these notches the canvas top may be placed at varying heights. The canvas top is attached to two strong wooden rollers, one of which is provided with a ratchet for securing the desired tension. When the canvas is stretched taut it obviates any possibility of the patient coming into contact with the tube terminals or with any part of the high tension line. It also will support sheets of lead with suitable openings or any amount of leaded rubber which the operator may desire to use. The head of the table is provided with a ten-inch wooden headrest, which is supported at an angle on wooden pins, driven into the sides of the upright corner posts. The elevation of this support at the extreme end is four inches. The table is equipped with good ball-bearing castors, and with the exception of these and the small ratchet arrangement on the canvas top, no metal is used in its construction. The body of the table is made comfortable by means of sufficient padding under the leather over the basket-weave canvas strips, which are placed on the frame for elasticity. Among the numerous advantages of this table are its simplicity of construction anqd operation, its comfort, its convenient height and the protection from the electric spark.

BERNARD H. NICHOLS,
Head of Section of Roentgenology, Cleveland Clinic, Cleveland, Ohio.

Therapy Protective Support

THIS device consists of two supports made of wood. These supports are exactly alike. The veneered wooden base measures eighteen by sixteen inches and is three-eighths of an inch thick. Two uprights, two inches wide and one inch thick, extend nineteen inches above the base and, for better support, extend three inches below it.



They are connected by a strip of half-inch light wood, three inches wide. At intervals of two inches the uprights are bored with holes for pegs by means of which cross bars may be adjusted. This adjustment is made according to the thickness of the patient.

The cross bars consist of two inch strips, twenty-five inches long, morticed at both ends to fit over the upright. These are placed between the two supports and over them is built the lead protection. When not in use the supports may be turned upside down at the ends of the table.

Dental Film Holders

A SET of three dental film holders for use in making alveolar radiograms of the mandible are here shown.

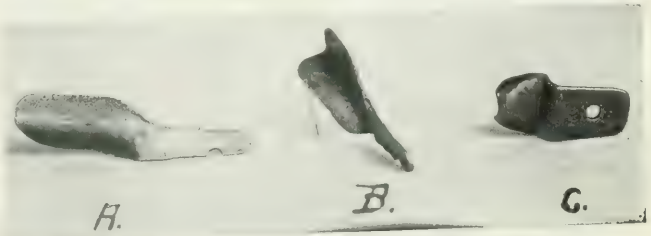
A and B show holders used for all teeth except the central and lateral incisors; for these use C.

These film holders are modeled out of ordinary white metal dental impression trays. This metal is ideal in that it is soft enough to conform to slight variations of contour and is non-irritating to sensitive teeth.

Three are necessary; one (A) for the left side, will hold the two films usually required for making the cuspid, bicuspids and molars; one (B) for the same areas on the right side, and one (C) for the central and lateral incisors.

I have used these film holders since 1917 and have found them entirely satisfactory in every case where lower teeth areas were radiographed. They meet every requirement of technique—they are cheap, easily sterilized and practically indestructible.

W. A. RUSH. *Beatrice, Nebraska*



CASE REPORTS

Benign Spastic Stricture of Sigmoid

SPASMODIC stricture of the lower bowel, particularly of the sigmoid and rectum, has been much discussed, the majority of observers believing that spasmodic narrowing associated with true muscular hypertrophy never occurs. The following case report should therefore be of interest.

Mr. J. B., aged sixty-two, entered the Methodist Hospital of Indianapolis December 9, 1921, on the service of Dr. H. K. Turner. He complained of constipation beginning three months previously, two to seven days elapsing between bowel movements. Upon entrance, a week had passed without a bowel movement. Vomiting had occurred several times, especially after taking cathartics. He had lost fifteen pounds in weight. No other pertinent information was elicited.

He was apparently in no discomfort. Temperature, ninety-five degrees; pulse, ninety-two; respiration, twenty-six. Important findings were: abdomen distended, tympanitic, slightly rigid throughout, with no palpable masses; prostate hard, although not markedly enlarged.

Fluoroscopy of the barium enema December 10th showed delay in the upper rectum with considerable ballooning here before the sigmoid filled. As the remainder of the colon slowly filled, there was noted in the lower sigmoid a narrowing of the lumen about two inches long, apparently smooth in outline. This then diminished to the size shown in the radiograph here reproduced. The sigmoid was redundant, but not dilated. On account of the typical fluoroscopic appearance above described, our interpretation was spasm. A palpable mass in the left hypochondrium appeared to be extra-colonic, presumably in the small bowel. This remained unexplained, but probably was due to obstruction.

Fair movemens followed this, but nausea, vomiting and distention persisted. The surgical service considered the lesion carcinoma, with the patient in inoperable condition. Further x-ray study with antisposmodics was precluded by his poor condition, but fluoroscopy December 15th, showed a greatly dilated cecum full of barium from the previous examination. The usual laboratory tests gave no further information. Patient died December 16th.

Dr. J. H. Warvel, the hospital pathologist, reported autopsy findings in part as follows: Gross and misroscopic changes in the middle jejunum indicated beginning gangrene. No evidence of embolus was found in the nutrient vessels. The sigmoid about six inches above the anus appeared thickened and the longitudinal striations rather marked, the bowel here being patent. Microscopically, the sigmoid was normal except for thickening of the muscular coat. An abscess about one cm. in diameter was present on the inferior surface of the liver. Coronary sclerosis, chronic myocarditis and chronic interstitial nephritis were noted. The gall-bladder appeared normal. The appendix was small, six and one-half inches long, bound down posterior to the cecum and without apparent inflammation. The prostate was enlarged and the lateral lobes irregular in outline.

Possibly the fatal outcome here is attributable to mesenteric vascular occlusion, caused by factors not disclosed at autopsy. Much greater interest attaches to the spasmodic stricture first detected by roentgenoscopy and later confirmed at autopsy. It is important to note that neither history nor postmortem findings suggest old ulcer or fistula which might have caused local spasm followed by muscular hypertrophy. Reflex from the appendix should, however, be considered.

Hertz [1] discusses enterospasm of possibly similar type, with bibliography. Howship first described it in 1830, since when Cherchewsky (1883), Fleiner (1893), Mahieu and Roux (1905, 1908), and Hawkins (1906) have discussed it, some of them under the name of spastic constipation. Hertz does not mention roentgen examination of the lesion. He considers it an exaggerated reflex, due probably in most cases to hard feces, retention of which has usually resulted from ordinary neurasthenic constipation.

Ball [2] and Earle [3] doubt the existence of such enterospasm without local irritation. Lynch [4] has never seen an undoubted instance. Case [5] mentions having seen colon spasm of possibly similar type. The only mention of similar muscular hypertrophy found comes to our attention as this is ready for publication. Ashhurst [6] reports removal of a similarly spastic recto-sigmoid under the diagnosis of carcinoma, in which the barium enema had shown a circular serrated filling defect.

The symptoms noted by Hertz have been constipation, a dull abdominal aching and often tenesmus. Vomiting is rare. Peristalsis is neither visible nor palpable, and there is no marked distention above the contraction. Rarely, as in Ashhurst's patient, there may be acute severe colic. Naturally, the stools contain no blood.

Colon spasm associated with some more or less definite local or reflex cause is not unusual. The lesion described is new in our experience. Attention is called to the value of roentgen evidence in such a lesion with confusing clinical signs.

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Drs. Cole, Beeler and L. A. Smith, Indianapolis.

Glass in Brain

PATIENT: Age thirty years, male, white. While riding a bicycle patient was run down by an automobile. He was thrown upon the radiator, his head striking the headlight. Face was lacerated about the cheek and chin and there was a slight cut over the ear. After the wounds had been sutured and drainage established they seemed to be healing perfectly, when one morning, while dressing and making an examination of the wound, a pressure upon the temporal region caused the patient to fall to the floor, and it was some time before he regained consciousness. Patient was able to walk about, but he was very restless and his actions and speech were not normal.

Next day a radiograph was taken and showed a three-cornered foreign body and some loose fragments of shell, lying just above the external auditory

meatus. Upon operation a heavy piece of headlight glass one and one-fourth by one and one-half inches was found lying upon the dura mater. Glass and fragments of bone were removed and the wound sutured. Recovery was complete within two weeks.

Andrew W. Stevenson, M. D., *and* Robt. D. Wiswall, M. D., Vancouver, Wn.

ABSTRACTS and REVIEWS

Juvenile Deforming Osteochondritis, with Report of Cases. E. D. Fenner, M. D., New Orleans M. & S. J., April, 1922.

THE author presents a very excellent article on this interesting condition, described almost simultaneously, and independently by Legg, of Boston, Calve of France, Waldenstrom of Sweden and Perthes of Tubingen. Legg first published an account of the disease in February, 1910. The most interesting feature to radiologists is that, while the symptoms are so similar to tuberculosis of the hip, the radiographic appearances are conclusive and a definite diagnosis of deforming osteochondritis can be made from the x-ray image alone.

The author reports seven cases, one of which was bilateral W. W. W.

Low Back Pain, A Clinical Study of Its Cause. John T. O'Ferrall, M. D., Jour. Bone and Joint Surgery, April, 1922.

THIS author reviews forty cases of lumbosacral pain with regard to: method of onset, location of pain, effect on spinal motion, and association of infectious foci elsewhere in the body.

He regards the pathology as a sprain of the lumbosacral ligaments, entirely analagous to a sprain of any other joint, and attaches very little importance to bony abnormalities, or to x-ray examination unless fracture is present.

He considers that a secondary infection is frequently superimposed and that eradication of infectious foci should be a part of the routine treatment and this treatment should be based on the principles which apply to sprains elsewhere. W. W. W.

A Study of Two Hundred and Eight Cases of Lower Back Pain. J. R. Kuth, M. D., Jour. Bone and Joint Surgery, April, 1922.

THIS study of two hundred and eight cases of lower back pain does not include cases of manifest injury or disease of the lower back structures. The series includes one hundred and thirty-six males and seventy-two females, ranging from twelve to seventy years in age. The etiologic factors determined were as follows: *static* factors, such as short leg, old fracture of lower extremity, foot deformity, obesity, marked cases of general weakness. Four cases of this group showed definite lipping of one side of the fifth lumbar body; sixty cases are included in this group.

There were twenty-seven cases where *traumatic* factors entered; symptoms followed falls, direct blows, or sudden strains from lifting.

There were thirty-three cases where infections entered; there were definite local and general symptoms of infection, or the symptoms followed cold and exposure, or there was definite x-ray evidence of osteoarthritic changes. W. W. W.

Note on Sacralization of the Fifth Lumbar Vertebra. C. Thurstan Holland, D. L., M. R. C. S., *The University of Liverpool.* Jour. Bone and Joint Surgery, April, 1922.

THE author briefly reviews the growth of interest in this interesting anomaly, and cites ten cases which have come to his attention during the year 1921. He summarizes the causes of the symptoms which are usually found in these cases, i. e., pains of various sorts centering in the lower back. These symptoms have been said to be due to (1) actual pressure on nerves or nerve trunks, (2) ligamentous strain, (3) compression of soft tissues between bony joints, (4) arthritis when a joint is present, (5) bursitis when a bursa is present. W. W. W.

Causes of Back-Ache and Leg Pains. John H. Galbraith, M. D. Pa. J. Roentgenol., April, 1922, p. 23.

PAIN is caused by some irritation of the nervous arc and nervous affections are divided into four groups, namely, (1) organic nervous diseases and cord lesions, (2) diseases of the abdominal and pelvic organs, (3) osseous lesions, and (4) ligamentous and muscular lesions.

The last two are of especial interest to the roentgenologist and with respect to these there must be considered under the heading of this paper the following lesions and conditions: tumors, infections, normal variations, anomalies, trauma, sacro-iliac affections, static derangements. Tension, pressure, stress and strain are factors producing pain with these lesions.

Secondary carcinoma closely resembles tuberculous lesions; early symptoms are obscure and deformity is late or absent, owing to the greater density and size of the vertebrae. The x-ray findings may go from negative to gross findings in a very short period.

Syphilis of the vertebrae and sacrum comes more and more to notice, also chronic infectious spondylitis.

Acute suppurative disease of the lower back is rare but is sometimes found. The sacro-iliac region is more prone to this than other parts.

Focal infections, of which there are many possible sources are often accountable for the conditions under discussion.

Variations in size and shape of the different parts of the vertebrae and developmental anomalies present a great class of causes of back-ache and leg pains. Two types of back are presented; the long and slender one with long, narrow, individual vertebrae has wide intervening discs; the second type has shorter vertebrae with thin discs. Of the variations of different parts, deviations of the direction of the articular facets of the lumbar vertebrae are usually vertical but they may be crescentic or hook-shaped on one side or on both. Variations in size and shape of the transverse process of the fifth lumbar vertebrae may cause a bursa between it and the ilium or the top of the sacrum.

Archer O'Reilley of St. Louis recently published a report of the x-ray examination of three hundred cases of back-ache, with tracing for one hundred and ninety-nine of these. He divides the lumbosacral articulation into three definite types, with reference to the lumbosacral joints and the position of the sacrum with relation to the ilia and transverse processes of the fifth lumbar. There is a very wide variation in size, shape, and position here. The static disorders are closely associated with these variations for many of them give rise to faulty postures which in time cause stress and strain on the muscular and ligamentous structures.

Pain and tenderness of the fascia and ligaments of the feet may result from simple muscular insufficiency and the same thing occurs in the back.

Injuries to the fascia and ligaments are very slow in healing and this is the one important thing mentioned in regard to trauma.

The great bony lesion which may be present with only moderate disability, and the reverse conditions, are striking facts.

Sacro-iliac relaxation and so-called subluxations present a very interesting class of etiology. Chronic and acute sprains are two of the most common disorders. In all cases of pain in the leg or thigh with no local manifestation of disease the sacro-iliac joints should be thoroughly examined.

The Roentgen Examination of the Gastro-Intestinal Tract. Adolph Hartung, M. D. Illinois M. J., April, 1922, p. 258.

THE author's purpose is to give a comprehensive idea of the value of the roentgen examination in gastro-intestinal conditions and to point out the class of cases which especially call for this procedure.

Acute conditions usually contra-indicate giving an opaque meal, though very exceptionally roentgen diagnosis is necessary in these conditions, e. g., an abnormally located appendix may present a confusing symptomatology.

In a second group with unmistakable symptoms diagnosis may be made clinically. Nevertheless the roentgen examination is often of value here in showing associated lesions which have an important bearing upon the course to be pursued.

In a third group the cases are obscure and the true condition can be secured only by a combination of roentgen and laboratory findings plus clinical history.

As to technique, it is better that the same medium be constantly used for the suspension of barium sulphate (for the sake of comparative data) and this medium must have a food value if gastric stasis is the problem to be studied. Preliminary cathartics should not be given and the patient must come presenting an empty stomach for the examination. A mild, cleansing enema may be used to empty the colon before an opaque enema is given. This last is necessary if it is found impossible to obtain the information with the opaque meal first given. Three separate examinations should be made, one immediately, one six hours after the meal, and one twenty-four hours after the meal; additional ones may be necessary as well. The fluoroscope and plates, or films, should supplement each other.

A preliminary fluoroscopic examination of the chest and abdomen should be made, also one plate of the abdomen made to detect unsuspected lesions.

Beginning with the esophagus diverticula and strictures should be noted. Dysphagia, solid mediastinal tumors, aneurysms and abscesses associated with Pott's disease may be early differentiated.

The normal stomach shadow is hook-shaped in eighty per cent of cases, cow-horn shaped in ten to twenty per cent. The stomach's position is variable and its size dependent upon the volume of meal ingested. More important than these things is the manner of filling and the emptying time.

Gastric ulcers, if acute, may show no evidence. Chronic ulcers show the crater or filled up defect in the walls. Perforating ulcers, extended through the walls, show accessory sacs partly filled with the opaque meal and a bubble above this. Malignant ulcers frequently cannot be differentiated from simple ones, but if an ulcer is large it is suspicious. Attention is called to Carman's palpatory technique.

The filling defect is the important factor in diagnosis of gastric cancer, the lesion projecting into the lumen.

Emptying time varies greatly. The possibility of lues should always be considered.

Duodenal ulcers are more common than gastric ulcers. The acute form may give no indication of its presence, the chronic form will show filling irregularities and tenderness to pressure; these symptoms must be definite and constant to be used as a diagnostic basis. Duodenal diverticula are not infrequent.

The widely differing reports of percentages of gall stones demonstrated by the x-ay are probably due to differences of technique and to the class of cases examined. Definite information can be obtained in seventy-five per cent of gall-bladder troubles if proper technique is used.

As a rule pancreatic cysts and malignancies, hypernephromas, and retroperitoneal sarcomas can be demonstrated with porper care and technique.

Lesions of the small intestine are infrequently diagnosticated by the roentgen examination. Obstruction and attendant stasis and Lane's kinks can be shown here.

The normal appendix may be visualized sometimes, after the six-hour examination, more easily by the fluoroscope than by plates. Signs of its pathology are abnormal fixation, localized tenderness to pressure, abnormally long retention and irregularity of its lumen.

What has been said of the position of the normal stomach applies likewise to that of the colon. Stasis here should be ascribed to ptosis only after all possible organic causes have been ruled out. Diverticula are more common here than formerly was thought to be the case and they may or may not cause symptoms. Cancer of the colon usually shows up as an irregular filling defect with a variable amount of obstruction.

Tuberculous lesions of the stomach cannot be roentgenographically differentiated from any other gastric ulcer, though associated pulmonary tuberculosis renders such a diagnosis more probable. Tuberculous peritonitis with plastic adhesions shows fairly characteristic findings.

Marginal and Jejunal Ulcers Following Gastro-Enterostomy. F. C. Schuldt, M. D., F. A. C. S. Minn. Med., April, 1922.

THE ulcer may be situated in three anatomical areas, namely: on the gastric side; on the suture line; in the proximal limb, distal limb or mesenteric border of the jejunum. They are usually single, though several cases of multiple ulcers have been reported. Roojen's five types of jejunal ulcer are these: (1) without symptoms which heal, (2) with pronounced local and general symptoms, (3) with acute perforation, (4) with tumefaction and inflammatory infiltration into the anterior abdominal walls, and (5) ulcers which develop jejuno-colic fistulae.

In one case, reported in detail, the x-ray findings were quite definite. There was a penetrating ulcer and a constant incisura on the lesser curvature opposite the ulcer.

The author discusses the etiological factors at some length, summarizing them into the following: (1) faulty technique in control of bleeding, (2) unneutralized acid chyme, (3) nonabsorbable sutures for inner sutures, (4) too much clamping of tissues or a Murphy button, (5) infection.

W. W. W.

Maxillary Cysts. Fulton Risdon, M. B., D.D.S. Canadian Practitioner, April, 1922.

THESE cysts are here divided into two classes: those due to embryonic rests, and those due to preceding infection.

The diagnosis depends largely on the roentgenogram. Differentiation must be made from malignancy, lues, osteoma, fibroma, adenoma, adamantonoma, chondroma.

W. W. W.

Pneumo-Roentgenography of the Kidney. Am. J. Surgery, March, 1922, p. 75. (Excerpt from editorial.)

CARELLI of Buenos Aires evolved a much more accurate method (than palpation). Adopting the principle of pneumo-roentgenography * * * he has applied it to perirenal inflation and has evolved a technique which, in his hands, is safe and harmless and

makes demonstrable the shadow of the kidney as clearly as does pneumoperitoenum the shadow of the liver and spleen. The injection is made with a needle close to the lateral process of the second lumbar vertebra. The technique must be very precise and carefully controlled by the manometer. Five hundred cc. of oxygen or of carbon dioxide may be injected, the latter has the advantage of being more rapidly absorbed. Deformities of the kidney outline, such as might be produced by tumors or other gross lesions, are demonstrable." The shadow of the adrenal glands is also shown by Carelli's method which he has recently demonstrated in this country.

X-ray Diagnosis of Aortitis. Thomas Frazer, M. D., *and* John D. MacRae, M. D. Southern M. J., April, 1922, p. 261.

IT IS true that a careful history and physical examination is often all that is necessary to diagnose this lesion but signs and symptoms are not always commensurate with the changes actually existing; because of this fact the x-ray is a most useful aid in diagnosis and its use, at times, leads to the discovery of an aortitis or aneurism which otherwise would not be detected.

Knowledge of the pathology of the heart and great vessels and considerable technical skill is requisite for this diagnosis. Both the fluoroscope and plates should be employed; with the former should be noted, the shape of the heart, its position, action, and relation to other thoracic organs. Pulsation in tumors adjacent to the heart and great vessels can also be detected by the fluoroscope. For the radiograph the patient should sit erect, chest against the film, and the tube at the back so that the ray will pass through the spine of the seventh dorsal vertebra to the center of the film or plate six feet away.

One technique should be constantly adhered to and the examination should be conducted in routine manner. By the study of many normal hearts of different ages (though these will vary in type) an accurate knowledge of the anatomy of the normal heart will be acquired. The characteristic curves for the left border of the arch of the aorta will be the same for all types: the pulmonary artery, the left auricle and the left ventricle will be on the left of the midline of the chest; on the right is the curve representing the ascending aorta and the right auricle. This normal contour will be changed in aortitis and in aneurism. Saccular aneurisms of the ascending portion lie chiefly to the right of the midline; those of the transverse arch cast shadows in the upper mediastinum, extending right or left. Aneurisms affecting the descending portion of the arch lie to the left of the midline. Illustrations accompany this description, also the following.

Aortitis with dilation frequently is not recognized until an x-ray examination is made. This type of disease is more often found in the ascending arch but may involve the transverse portion. Both dilation and elongation of the entire arch may be present, or there may be an abnormally broad aortal shadow. Widening and elongation of the aorta is often encountered in individuals past middle age and this fact must be borne in mind.

The Diagnosis of Chronic Appendicitis. Franklin B. Bogart, M. D., and W. H. Cheney, M. D. Jour. Tennessee State M. A., March, 1922, p. 410.

CHRONIC appendicitis may cause a great variety of symptoms, even when abdominal symptoms are slight. Diagnosis then becomes difficult and diagnostic studies should be full and complete before an opinion becomes a diagnosis. History, physical signs, gastric analysis, blood examination, radiographci examination, and differential diagnosis are all discussed.

The following is an abstract of the discussion of radiographic examination: A diagnosis of chronic appendicitis is rarely justifiable without first making plates and a fluoroscopic examination. This will eliminate certain factors from the diagnosis and will, if chronic appendicitis exists, give definite evidence. Gastric or duodenal ulcer, also some kidney conditions, may simulate chronic appendicitis. The same is true of gallbladder disease and of pelvic disease.

The writers favor the buttermilk meal for visualizing the appendix. On the first day four ounces of cream of wheat and four ounces of barium sulphate are given (for accurate reading of motility of food), on the second day a suspension of four ounces of barium sulphate in buttermilk is given while the patient is being fluoroscoped. When the appendix is visualized the following points should be noted:

(1) *Size, length, and calibre.* Normally narrow and ribbon-shaped, average length three to five inches, may be ten inches long. (2) *Appearance.* Normally uniform in diameter, abnormally kinked, looped, constricted, or vacuolated. (3) *Direction.* Normally directed downward, abnormally directed in any direction. (4) *Fixity.* Normally freely movable, abnormally may be adherent anywhere along its course. (5) *Tenderness.* Elicited by direct palpation of visualized organ. (6) *Emptying time.* Normally begins to fill at six-hour period after ingestion of barium meal, should begin to empty after twenty- four hours. Abnormally may remain filled many days.

If visualization cannot be accomplished by anterior-posterior plates it may be accomplished by oblique plates or by manipulation under the fluoroscope.

Other valuable information which may be gained from radiographic examination, and which is indicative of chronic appendicitis or of ileo-cecal adhesions are: stasis in the ileum, cecal stasis, adhesions between terminal loop of ileum and the cecum, incompetent ileo-cecal valve, tenderness and lack of free motility of the cecum, stone in the appendix.

Hypermotility, spasm at the center of stomach, pyloraspasm, atonic conditions, entero-spasm at the center of the transverse colon, and pressure over the region of the appendix causing visible spasm of the stomach wall (fluoroscopically) may be caused by chronic appendicitis, and their presence, or that of any one of them, should lead to careful examination of the lower right quadrant.

In the author's experience when the head of the barium column has not entered the cecum at the end of the six-hour period there is invariably chronic appendicitis present, or at least a chronic inflammatory involvement of the ileo-cecal region.

Pneumoperitoneum. Chas. L. Martin, M. D., Dallas, Texas. Texas State J. Med., April, 1922.

THIS article is a brief summary, written for the general profession, of the advantages in the pneumoperitoneal method in radiologic examination. The first observation on this method was made by Kelling in 1902, but little attention was paid to it until 1910 when Jacobaeus of Stockholm began using it in diagnosis. Dr. Orndoff, of Chicago, began its use about 1917, and Drs. Stewart and Stein of New York in 1919; the latter workers published the first report in American literature in November, 1919. Sante, Van Zwaluwenburg, Alvarez, Tyler and Rubin are quoted as having done valuable work with this method.

W. W. W.

The Business Side of X-ray Diagnosis and Treatment. E. M. Sunderlof, M. D. Bost. M. & S. J., March 30, 1922, p. 442.

DR. Sunderlof, in a letter to the editor of the above journal, forcefully presents the business problems of

the radiologist and suggests a way to set about the solution of one phase of these.

By radiologists here is meant the accredited, ethical physician who has made a special study of radiology and who devotes himself exclusively to x-ray diagnosis and treatment.

The average patient and the average doctor can with difficulty be convinced that the average fee charged by the radiologist is not an excessive one. Every radiologist at some time encounters this unpleasant (because unjust) attitude.

The writer believes that a lack of knowledge of the expense and hazards of the practice of radiology accounts for this attitude of general physicians, specialists, and their patients and he states that a better understanding is not at all helped by the fact that many x-ray laboratories run by laymen, with no supervising physician, turn out vast numbers of radiographs (without diagnosis) for a small fee. These are then "interpreted" by dentists, physicians, and surgeons, who either are not cognizant of their limited ability to do this without special preparation, or else will not admit this limitation. The patient believes he has had the best of service and consequently regards the fees charged by the radiological specialist, for supposedly the same work, as exhorbitant.

Furthermore, the hospitals are to blame in that they employ a technician instead of employing a competent and accredited radiologist (who of course cannot be secured for a technician's salary), and allow this technician to make the interpretations of plates and films. Many hospitals establish a fee list ranging from ten cents to ten dollars, which even with the comparatively low salaried worker employed does not approach the cost of equipment and running expenses. This sort of inferior service all over the country has the same influence that the commercial laboratory exerts.

Until the medical profession and the lay public are enlightened this sort of service will be rendered and accepted and the specialist in this line of work will continue to be misunderstood. Not only the lay public but many medical men are not sufficiently informed to know how much training enters in before a trustworthy diagnosis can be made, to say nothing of the enormous running expenses incurred by the specialist in radiology. He must have the best latest, largest, and most powerful equipment in variety sufficient to care for every case coming to him. The cost of installing this equipment would make even a plumber blush. Besides there must be lead lined walls, separate rooms for various purposes, light and power. Chemicals and supplies too varied to mention enter into the running cost. Salaries are no small item, nor is wholesome charity excluded from the list. And besides these actual running expenses back of the type of radiologist under discussion are years of study and practical application of not only general medical knowledge but the knowledge of his specialty, and, like the ancient Athenians, the radiologist engages in a never-ending pursuit after "some *new* thing."

To quote Dr. Sunderlof's closing paragraph: "A sliding scale of fees is reasonable and just. The maximum fee that most radiologists ask is seldom —in fact, I think, has never been—excessive. If doctors in general *understand* the radiologist's work, the expense connected with it, the expenditure of time and energy involved, and the danger the radiologist faces, and explain these facts to their patients, a majority of the unpleasant discontent with the radiologist's fee would cease. The radiologist should never be a piece worker and commercialize his work by charging so much per plate. A true radiologist is a consultant and as such is entitled to a reasonably high fee for his expert knowledge and opinion."

The Prevention of Rickets in the Rat by Means of Radiation with the Mercury Vapor Quartz Lamp. G.F. Powers *and* E. A. Park, *Yale University;* P. G. Shipley, *Johns Hopkins University;* E. V. McCollum *and* Nina Simmonds, *Johns Hopkins University.* Bull. Johns Hopkins Hosp., April 1922, p. 125.

IN a previous article these authors showed that rats placed upon a rickets producing diet did not develop rickets if exposed to direct sunlight. In that communication attention also was called to the fact that other radiation than sunlight had been used in the treatment of human beings having rickets. The x-ray and the mercury vapor quartz lamp were two of these forms of light.

The authors' summary is quoted here:

"(1) The object of the experiments was to determine whether or not radiations from a mercury vapor quartz lamp would prevent the development of rickets in the rat.

"(2) A diet was employed which at room light regularly gives rise to a disease identical in its essential features with rickets as seen in the human being. The diet was high in calcium, low in phosphorus and was insufficiently supplied with fat-soluble A. In other respects it was well constituted.

"(3) Nineteen rats were placed on the diet. Ten were exposed to radiations from a Hanovia 'Alpine' mercury vapor quartz lamp for varying periods of time (two to six hours) daily over a period of sixty-four days. Nine rats were kept as controls under conditions of ordinary room light.

"(4) One of the control animals was killed after thirty-eight days; another after fifty-eight days, and the remaining seven after sixty-four days. All of these animals showed gross and microscopic evidence of rickets.

"(5) The ten rats exposed to the radiations from the mercury vapor quartz lamp were killed after sixty-four days. These animals were free from rickets, both grossly and histologically.

"(6) The beneficial effects of the radiations from the mercury vapor quartz lamp were not limited to the skeleton, since the condition of the rayed animals underwent a general improvement." While the rayed animals were extremely active and always hungry, the controls were decidedly less active, had a "waddling gait," and did not eat as much as the others. One of the rayed animals gave birth to six young the thirty-seventh day of the experiment.

"(7) The effects of the radiations of the mercury vapor quartz lamp on the growth and calcification of the skeleton of the rat and on the animal as a whole seem to be similar to, if not identical with, those brought about by the direct sunlight and by cod-liver oil."

Studies on X-ray Effects. The Biological Action of Small Doses of Low Frequency X-rays. Waro Nakahara, Ph. D., *and* James B. Murphy, M. D., *Rockefeller Institute for Medical Research.* J. Exper. Med., April, 1922, p. 475.

PRESENT apparatus renders futile attempts so far made to compare the biological action of the soft, or low frequency, x-rays with the hard, or high frequency rays. But by varying the doses of both kinds of rays it seems definitely proved that with the softer rays it is possible to induce an apparent stimulation of the lymphoid cells preceded by only a very short and transitory period of depression. With the hard rays the stimulation phase is less pronounced.

The study here recounted deals with the effect of still softer x-rays than those used in previous experiments and for the generation of these rays the special tube described below was used.

The following is the authors' summary of this study:

"A study has been made of the biological effect of a small dose of soft x-rays given off by a special water-cooled tube with a window of thin glass, operated at one-half inch spark gap and eleven ma. Mice exposed for one minute show, two days later, in the blood an increase in the number of lymphocytes and in the lymphoid organs an increased number of mitotic figures. There occurs also a marked dilation of the vessels of the suprarenals, particularly between the cortex and the medulla. The latter condition did not appear until after twenty-four hours, and was still present fourteen days after treatment. No change was detected in other organs.

"Mice treated in this way showed a high degree of resistance to cancer transplants. The amount of resistance varied with the time of the inoculation after the treatment. The resistance was not increased before three days after, and was at its highest point ten days after the treatment."

The authors state further that, so far as is at present known, the only physical or chemical change induced by the x-ray depends upon its power to ionize; if this be true it is still a problem why some types of animal cells are so profoundly affected and others not at all affected by the x-ray.

That a biological change may be induced by a small dose of very soft x-rays is here shown, but no reaction of this nature with harder rays could be obtained. Until it has been determined that the dosage is the same, the question whether this is a real difference in biological action must remain unanswered.

The writers do not believe that the changes here wrought in the lymphoid organs are the result of direct action of the rays. They incline to this opinion partly because of the small dosage and partly because the deeper nodes reacted as much as more superficial ones. The significance of the changes in the suprarenals is not yet understood. The testicle and ovary, supposed to be extremely sensitive, are not at all affected by this treatment.

The virulence of the strain of tumor used to test the resistance of the mice was such that so-called natural resistance was almost completely obviated.

Studies on X-ray Effects—The Fate of Cancer Grafts Implanted in Subcutaneous Tissue Previously Exposed to X-rays. J. Henk Liu, M. D., Ernest Sturm, M. D., *and* Jas. B. Murphy, M. D., *Rockefeller Institute for Medical Research.* J. Exper. Med., April, 1922, p. 487.

IT has been shown by Murphy, Hussey, Nakahara and Sturm that an erythema dose of x-rays produces in the skin layers of mice a reaction characterized by lymphoid infiltration coincident with a local increase in resistance to transplanted cancer. These x-ray areas are refractory to subsequent intracutaneous inoculation of cancer, but subcutaneous inoculation beneath the x-rayed areas results in the same number of growths as in normal areas. This furnishes a possible explanation of the different reactions to x-rays of skin cancer in man and the same cancer in the superficial lymph nodes of man.

To determine whether direct exposure of the deeper tissues renders them refractory to implanted cancer, a series of experiments were carried out upon normal white mice.

In one series tumor inoculation was made after exposure of the subcutaneous tissue to x-rays, using a three inch spark gap, ten ma., six inch distance, two and one-half minutes, over an area of about one and one-half cm. extending laterally across the abdomen; all the rest of the animal's body was protected by sheet lead. The average resistance of these animals was sixty-six and one-tenth per cent. The average resistance of the controls was seventeen and four-tenths per cent.

In the next series the same exposure was made over the skin intact. Afterwards incision and inoculation were made. The tumor grew in all of these.

In another series, after a local exposure of subcutaneous tissue to the rays inoculation was made in a protected area and was successful in nearly the same percentage as in the normal control animals.

The authors' summary is as follows:

"An erythema dose of x-rays given direct to the exposed subcutaneous tissue and muscle greatly diminishes the susceptibility of the exposed area to transplanted cancer. The same dose given over the intact skin does not affect the resisting power of the underlying subcutaneous tissue.

"Histological examination shows that a few days after the exposure of the subcutaneous tissue there is a lymphoid infiltration of this tissue, which infiltration sometimes includes the muscle layers as well."

Action of Radium and the X-rays on the Blood Forming Organs. Isaac Levin, M. D. Am. J. Roentgenol., February, 1922, p. 112.

KNOWLEDGE of the individual function and correlation of erythrocytes, polymophonuclear neutrophile leukocytes, and the lymphocytes, is yet incomplete, and this makes difficult the correct estimation of the mechanism of the action of any agent upon the blood and the blood-forming organs.

As a general rule the action of radium and x-ray on the normal blood diminishes the number of lymphocytes and relatively increases the number of polymorphnuclear leukocytes.

Connective tissue formation can take place only when the lyphocytes and lymphoid tissue of the organism remain intact, therefore, the influence of x-ray and radium upon these is of the greatest significance.

Previous experimentation on turtles' blood by this method showed that the numerical relationship between the leukocytes and lymphocytes changes greatly soon after radiation, then gradually reutrns to normal, and at the end of twelve days the blood contains the same relative number of cells as before radiation.

The experimentation here recounted consisted of subjecting to radium and x-rays normal frogs, and also frogs in which a change in the white blood cells had been brought about by a preliminary injection of yeast. A similar study was carried out upon rabbits.

A total and differential blood count of each animal was taken before treatment. The whole body of the frog was exposed for fully five minutes, using a Coolidge tube, nine inch spark gap, seven ma., eight inch focal distance, no filtration. Blood counts taken at intervals for four days gave a total leukocyte count only slightly different from the normal count. The differential count showed a marked change in numerical relationship between the polymorphonuclear leukocytes and the lymphocytes. The number of eosinophiles and transitionals remained practically the same. The blood became normal in about four days.

From 1.0 to 9.6 of radium emanation in glass tubes was introduced into the dorsal lymph-sac of a frog and results were analogous to those just recounted—the only difference being in the time at which change was most marked, twenty-four hours with x-ray and seventy-two with radium.

The injection of yeast into normal frogs produced a blood change similar to that produced by x-ray and radium, and when these agents were then applied no further change was induced.

Experimentation upon the rabbits yielded identical results when x-ray was used. Radium experimentation was carried out by inserting from two to four radium emanation capillaries into the spleen, and in another series of animals, into the long bone. Examina-

tion showed no change in blood structure. The reason for this is that the effect is distributed, in the rabbit, in a larger quantity of blood than in the frog. On the other hand the square surface of the rabbit's body is greater than that of the frog, and so under the same exposure to x-rays the rabbit's body received a greater amount of radiation. Biologically these dosages of x-rays and radium are analogous, for they produce an identical effect upon the frog's blood.

Radium, as compared with x-rays, will produce the same and even a more marked local effect with far less general disturbance of the blood. The larger the square surface of entry for x-rays the more severe is the general effect upon the blood. Biological conditions as well as purely physical conditions are a factor in estimation of correct quantity and quality of radiation.

Dr. Schmitz in his discussion stated that unless there was an active decrease in the total number of corpuscles there was no real effect manifested.

Self-Retaining Radium Holder for Tonsil Work. Cosby Swanson, M. D., *and* William H. Hailey, M. D., Atlanta, Ga. Jour, A. M. A., April 15, 1922, p. 1125.

BY removing the spring clamps holding the gauze pad, also the knob, from the inner blade of a Corwin tonsil hemostat, enlarging the hole in the inner blade to fit the peg on a thirty mg. oval radium plaque, and placing a rubber cot over the radium and inner blade the writers made a practical device for holding radium against the tonsil.

Metatarsophalangeal Fractures, With Report of Twenty-seven Cases. By Alfred G. Bolduc, M. D., J. Industrial Hygiene, April, 1922.

AFTER several years' study of foot injuries, the x-ray is the only certain method of ascertaining the existence or non-existence of metatarsophalangeal fractures, and all foot injuries should be radiographed. The fractures found in this series were, in order of frequency, chip fractures, proximal phalanx fractures, metatarsal fractures. In comminuted fractures of the distal phalanges, surgical treatment is indicated, conservative treatment being of little avail. End results are good if properly handled. W. W. W.

The Early Diagnosis and Treatment of Hyperthyroidism. Emil Goetsch, M. D. N. Y. Med. J., March 15, 1922.

THIS fairly comprehensive article on hyperthyroidism, outlines the early symptoms, the pathological changes, clinical tests, including, of course, the Goetsch test.

The treatment is discussed under medical, x-ray and surgical headings. The x-ray treatment is commended as a pre-operative method in a limited number of cases and "damned with faint praise" when regarded as a method of treatment per se. The article rightly emphasizes the difficulties and dangers both of x-ray and surgical methods of treatment, and insists that, in either instance, these cases can only be handled by those with particular training and experience.

W. W. W.

Hyperthyroidism. By Israel Bram, M. D. N. Y. M. J., March 15, 1922.

THIS article, which immediately follows the one by Goetsch, illustrates the wide diversity of opinion in regard to thyroid conditions, and justifies the radiologist in holding to his own opinions and treating thyroid conditions as he himself thinks best. Bram concludes his argument for purely medical handling of thyroids by the statement: "In brief, the properly equipped internist, after eliminating those who are moribund the insane, and the non-operative, should obtain approximately one hundred per cent recoveries."

This author does discuss x-ray as an adjuvant to other non-surgical measures in cases where the thyroid hyperplasia is unusually great.

This article and the preceding one, by Goetsch, are well worth reading, because they will stimulate the radiologist to continue the excellent work he is doing in thyroid diseases.

A Plea for Early Diagnosis and Treatment of Hyperthyroidism. C. W. Dowden, M. D., *and* C. D. Enfield, M. D. Kentucky M. J., March 1922, p. 196.

TREATMENT of hyperthyroidism, to be entirely satisfactory, must be instituted in the earlier stages of the disease, before organic damage has been wrought.

The bearing of the basal metabolic rate, the use of adrenalin (for observation of pulse, blood pressure and tremor), and the sugar tolerance test are discussed. The adrenalin test the author does not regard as useful. Vague and indefinite symptoms are also discussed.

It is asserted by the writer that no medical treatment of hyperthyroidism has as yet stood the test of time. Surgery and roentgenotherapy are the only means of therapy that these writers regard as useful in this disease.

Crile's summary of the relative advantages and disadvantages of surgical and x-ray treatment are discussed and Crile's statement that operation is not more painful than x-ray is criticised, because x-ray has no attendant discomfort. A contrast is drawn between the period of incapacitation following surgery and the relatively very little time required for roentgenotherapy of this lesion. While Crile shows a one per cent death rate in his statistics, x-ray statistics show absolute lack of mortality applied to this particular treatment. In answer to the statement of Crile that surgery is the more curative treatment the authors of this paper reply that since many patients will not submit to surgical treatment, but will submit to x-ray in the early and curable stage of the disease, that x-ray therefore could and does often prevent a fatal outcome in these particular cases. Also the authors favor roentgenotherapy because of the fact that it attempts to restore the normal thyroxin balance without a mass attack. If this attempt fails surgery is still an open recourse.

The technique employed by these authors is as follows: The basal metabolism test, the Goetsch test and the sugar tolerance test are all made before x-ray is given. Three areas are treated, one on the right over the thyroid going to the middle line, similarly one on the left, and a third one over the thymus region. Eighty kv. (about eight and one-half inch spark gap), five ma., twelve inches anode-skin distance, four mm. aluminum and one cm. of sole leather, ten to fifteen minutes exposure at intervals of a week or ten days. Six such treatments are given unless the pulse drops rapidly after the first three or four treatments.

After a period of two to three weeks the metabolic rate is again taken. If this is still high only a month's rest is given and a second series of similar treatments is then employed. Otherwise a three months period is allowed to elapse and the basal metabolic rate is then again determined.

Complete cure, as far as symptoms and laboratory tests can determine this, has been accomplished in some cases and decided relief has resulted in others. Case reports are appended.

The Actinic Ray. C. B. Witter, M. D. Albany Medical Annals, March, 1922, p. 125.

THE blue and violet rays are the shortest visible rays of sunlight. Beyond these are the shorter invisible ultra violet rays, and beyond these the roentgen rays and the radium gamma rays.

At high altitudes the ultra violet rays are present in large quantities in sunlight, but at lower altitudes the dust particles and moisture in the air filter out and absorb these rays.

Bovie of Harvard, and Beige of the University of Illinois have proved that ultra violet light will kill bacteria within five minutes.

The ultra violet ray has four important effects: photochemical, ionic, fluorescent, and biologic. It has a biological effect as the result of local activity and general systemic action. The local activity ranges from slight capillary engorgement to exudative inflammation. As for systemic effect, the time and intensity depend upon the reaction sought, as the actinic ray produces changes in the quality of the blood, a leukopenia and subsequent leukocystosis.

The three types of reaction of therapeutic value are: stimulative erythema, regenerative erythema, and destructive erythema. Dosages producing these are used respectively as is sought a bactericidal and stimulative effect, or this plus capillary reaction, or these two effects plus destruction of cellular layers.

Actinotherapy in General Practice. F. J. Kern, M. D. Ohio State M. J., April, 1922, p. 286.

THE writer states that in the role of a doubting Thomas he began the use of actinic rays in his general practice and that he has treated several thousand cases by this means with such results that he now considers this form of therapy to be one of the most useful and valuable of aids.

The following cases are reported from his practice: sciatic neuritis, pruritis, tonsillitis and mumps, mumps, scabies, epididymitis (gonorrheal, also tuberculous), acute nephritis, pulmonary tuberculosis, "rheumatism," chorea, cellulitis, carbuncle, leukorrhea, chronic eczema. Some of these cases were cured and other benefited by the rays. The writer's conclusions are:

1. Actinotherapy is an effective mode of treating many chronic and obscure cases which the general practitioner has, heretofore, had to refer to the specialist.

2. Ultra violet rays are antiseptic, bactericidal, markedly analgesic, nerve sedative, and greatly assist in promoting the general metabolism.

3. Actinotherapy is one of the best treatments in early stages of tuberculosis wherever found, and far superior to natural sunlight on account of its applicability at all places and in all climates. It is of especial merit to patients who are unable to go to sanitaria.

4. In simple neuralgia and neuritis the actinic rays are almost specific, giving in many instances almost instant relief.

5. Severe reactions and prolonged treatment are often necessary to obtain satisfactory results in some chronic cases.

6. Only those who use this modality persistently and conscientiously know its real value.

The Ultra Violet Ray in the Treatment of Roentgen Ray Telangiectasis. H. H. Hazen, M. D. Am. J. Roentgenol., Feb., 1922, p. 101

DR. Hazen states that he does not advocate the use of the Kromayer lamp for all skin affections but that he has been very successful in obliterating the dilated blood-vessels of telangiectasis by this means.

Fifteen to twenty minutes to each area, using a quartz compression lens with an active lamp has accomplished this effect in from one to two treatments. Eight lesions, two of them large ones, have been successfully treated. A slightly whitened scar is the resultant appearance of the area treated.

The Cancer Problem in the Southern States. Frederick L. Hoffman, *Statistician, The Prudential Insurance Company of America.* J. S. Carolina M. A., March, 1922, p. 51.

THE cancer rate in the United States is lower in the north and west than it is in the south, though the data upon which this information is founded are not entirely satisfactory to the statistician, as data for southern rural territory are unavailable as yet.

In general, the cancer rate among the colored population of the south is lower than among the whites, though the reverse is true of uterine tumors in particular.

Cancer is practically *nil* among the native races of the tropics. The writer believes that this is primarily a matter of nutrition, style of clothing, and general environment. The protein content of their food is less and their clothing always loose. Among the negroes of our south, before the Civil War, cancer was practically an unknown occurrence, but today it is common among them. The writer attributes this change to (1) adoption of white people's mode of clothing, (2) hypernutrition, (3) lower birth rate (abortions), (4) artificial feeding of infants (interference with normal lactation), (5) modern housing with its attendant exposure to sulphurous contents of coal smoke.

Theories of infection, contagion, and heredity are not supported by the general history of cancer, but it is noted that cancer oftener occurs among the well to do and healthy than among the poor and diseased.

The writer believes that negative evidence rightly applied may lead to more important discoveries in regard to prevention than biological investigation has yet produced.

The tumor problem, benign and malignant, as it affects the southern negro women, is an urgent one, as uterine fibroids are of extraordinary frequency among them. In justice to the white people of the south, he states that wherever cancer therapy is available for them it is also available for the colored population, however poor the latter may be.

The Radiation Treatment of Hpertrophied Tonsils. Herman A. Osgood, M. D. Am. J. Electroth. and Radiol, March, 1922, p. 79.

THE x-ray treatment of hypertrophied tonsils aims at the reduction and atrophy of the lymphoid elements in the lymphoid tissue, which is very susceptible to radiation. Radiation does not produce a bactericidal effect, but mechanical eversion of the crypts is brought about by shrinkage of the lymphoid elements. The resultant proper drainage eliminates bacterial infection in properly selected cases.

Cases must be properly selected—atrophic infected tonsils, or those with buried abscesses are unsuitable for treatment. Results, with proper technique, are reasonably sure and the discomfort slight.

Proper protective measures and proper dosage must be observed. Inexperienced operators are apt to try to hasten matters by increasing the dosage. The technique in average cases is: For adults—spark gap, seven inches; ma. five; filters, three mm. aluminum; distance, ten inches; time, five minutes. For children, subtract approximately one-fourth minute for every year under sixteen. Factors used with one machine are not necessarily applicable to another, and strict adherence to the limits of safety must be observed. The above dose is usually given at intervals of two weeks, and from six to eight times. If large doses are given the intervals between must be from three to four weeks. Usually two large doses are required for adults and smaller doses at more frequent intervals for children.

Radium may be used intra-orally, combined with extra-oral x-ray treatment. A thirty to fifty milligram plaque brought into direct contact with the large tonsil is used, previously swabbing the throat with novocain. Radiation therapy of the tonsils is not urged as a replacement of tonsillectomy, but is especially indicated in case of cardiac, renal, or pulmonary complications. It has the disadvantages of re-

quiring longer time and suitable selection and the advantages of no danger from anesthetic, hemorrhage, or pulmonary complication.

Radium Therapy. By Wm. D. Haggard, M. D., and Carl R. Crutchfield, M. D., J. Tenn. M. A., March, 1922.

THESE authors make a preliminary report on two hundred and fifty cases treated with radium, since 1917. Of these one hundred and forty-five were carcinoma, twenty-four sarcoma, seventy-one benign. Of the one hundred and sixty-nine malignancies, one hundred and eleven are living, forty-two dead; of the twenty-four sarcomata, fourteen are living.

Sarcoma has given the best immediate results, although showing the usually reported tendency to develop metastases.

Skin cancers showed from eighty-five to ninety-five per cent of permanent cures. Cancer of the lip springing from the skin surface should be treated by radium; springing from the mucous membrane it should be treated by combining radium with surgery..

In cancer of the cervix, radium gave apparent local and clinical cures in from twenty-five to thirty per cent of cases, and as a palliative, its effect justified its routine application.

Cancer of the rectum was unsatisfactory when treated with radium alone, and surgical combinations are advised.

All the non-malignant conditions gave satisfactory permanent results; these included port wine stains, birth marks, forty per cent of uterine fibroids, idiopathic uterine hemorrhage at the menopause, and so-called precancerous lesions. W. W. W.

A New X-ray Technique in the Treatment of Malignancies. Wm. H. Dieffenbach, M. D., J. of Inst. of Homeopathy, April, 1922.

THIS author describes his method of utilizing secondary rays, either scattered rays, beta rays, or characteristic rays. He does this by means of cataphoresis plus the parent x-ray; he impregnates the lesions with argyrol by cataphoresis and then administers the x-ray dosage. The method of inserting metallic plated instruments into lesions, or into body cavities, and then administering the x-ray dosage, is described. W. W. W.

Radium Therapy of Cancer of the Mouth and Throat, by Everett Field, M. D., N. Y. State J. Med., March, 1922.

THE author discusses the treatment of these very difficult cases, and insists that coagulation necrosis is frequently a necessary adjunct to radium in the mouth and throat. In carcinoma of the jaws, buccal cavity and larynx, radium has a limited advantage and permanent results are seldom secured.

For preoperative effect on neck glands to prevent metastases, about three thousand milligram hours are required, filtered through one and one-half mm. of brass at two cm. distance.

In lip epithelioma, from fifty to two hundred milligram hours through one-half to one mm. of metal and two to four mm. of rubber; where nodular masses are present, needles of radium element, thirty milligram hours per cc. of tissue is effective. In tumors of epiglottis or larynx, twenty-five to thirty-five milligram hours per cc. of tissue by buried needles is advised, with cross fire of about two thousand milligram hours from the outside.

This author does not believe that buried emanation is superior to needles. W. W. W.

Radium and Deep Therapy in the Treatment of Malignancy. Russell H. Boggs, M. D., Pa. J. Roentgenol, April, 1922, p. 4.

INSUFFICIENT equipment and lack of technique, plus extravagant claims characterize the early days of x-ray treatment and good results in the treatment of basal cell epithelioma was the first, and for some time the only therapeutic triumph in the x-ray field.

Filtration and cross firing marked the beginning of a new chapter in x-ray history and likewise the new transformers now on the market will write still another one. These will bring changes in technique, and until these are definitely fixed, caution must be used.

In the case of radium, more uniform results are now secured. Small or large quantities are prescribed, according to the size and depth of the lesion.

In general, the science of radiotherapy has so advanced that in the treatment of some types of malignancy it is superior to and has replaced surgery.

In radiotherapy a lethal dose must be given to all deep carcinomatous tissues, this usually requires from seven to ten skin erythema doses, four inches below the surface of the skin.

For epithelioma and for malignancies of the mouth and throat radium is more efficient than surgery, because cancerous dissemination in the lymphatic spaces and glands, even at a considerable distance from the primary focus, is usually present, even in the early stages. For the treatment of these malignancies a thorough knowledge of the anatomy of the lymphatic system of these regions is imperative.

Good results in carcinoma of the tongue are difficult to obtain, because of early metastases. The grooves between the tongue and the tonsil must always receive radiation. Extensive surface radiation, together with intensive radiation of the lymphatics, combined with buried radium in tongue and tonsil should give the best results, and in some cases should be followed by electro-coagulation. If operation is performed radiation should precede it by five or six weeks. Radium is the treatment of choice in most cases, however, as more cures result from its use (the disease being removed without opening the lymphatics), it causes no deformity and patients will earlier submit their case to it than to surgery.

In sarcoma of the tonsil and throat, a clinical, but not a lasting cure, can be obtained. A better understanding of this type of lesion has led to deep radiation of the glands of both sides of the neck as well as the mediastinum, and better results are hoped for in the future.

Cancer of the breast, because of its lymphatic supply, is most difficult to treat and also because of this fact radium and x-ray are preferable to surgery alone. Radium before and after operation is the method of choice in early cases, and in most advanced cases radiation without operation is best. Every chain of lymphatics should receive a lethal dose. The author uses surface applications of radium and x-ray, using high penetrating radiation, and as much cross fire as possible. Two to three weeks later radium nedles are inserted throughout the breast, into the axillary glands and the glandular tissue extending from the breast to the axilla, and also beneath the clavicle. In early cases operation should follow in from four to eight weeks following this; in some of the late cases removal of the breast (without opening the axilla) is advisable.

Gynecologists were the first surgeons to advise primary treatment of carcinoma of the cervix and uterus by radium; but because gynecologists and other surgeons have made use of inefficient quantities of radiation, combined with poor technique, and have in their treatment omitted the deep roentgenotherapy of adjacent glands, their efforts have not been successful and have led to their dissatisfaction with the method. The treatment of cancer by radiation is a specialty requiring comprehensive study, and he who lacks this cannot hope for success. On the other hand, the radiologist must be capable of diagnosing and differentiating the different steps of the disease or he likewise will do more harm than good.

Best results follow local treatment with radium, as much as the tissues will stand, combined with as much extensive radiation as the skin will tolerate.. Reports from the German clinics have led some astray in this matter. The author considers it as unwise to attempt to destroy cancer cells in the pelvis, through the skin, when these lesions can be treated locally by radium, as it would be to try to kill cancer cells in adjacent glands by local applications of radium.

Early cases of carcinoma of the cervix and uterus can be clinically cured by radium, but whether end results will prove equal or superior to surgical removal cannot yet be definitely decided. For border-line and advanced cases radium and deep therapy are best. In inoperable cases radium is a specific palliative, clinically curing about one-third of these cases and improving all others.

The Treatment of Malignant Tumors of the Pharynx and Larynx by Diathermy. Frank J. Novak, Jr., M. D., Illinois M. J., April, 1922, p. 252.

THE special application of diathermy to cancer of the larynx is recent. The great problem in diathermy has been the perfection of a high frequency apparatus capable of producing a current of low voltage, high amperage and extremely high frequency. The new Victor apparatus produces deep penetration of tissue without carbonization. The heat produced is the result of the resistance of tissues to the high frequency of the D'Arsonval current.

The principal of diathermy is based upon the facts that local application of sufficient heat to a neoplasm destroys the tumor mass, and that lower degrees of heat applied to the periphery of the mass and beyond inhibits the growth of the migrating neoplastic cells. The occlusion of lymph spaces and channels and the function of scar tissue aid this last process.

In the early stages of carcinoma of the larynx the author believes that diathermy is the treatment of choice. The consensus of opinion of those using this method is that its combination with radiation gives mutual advantages to each method, which either one used alone does not possess.

The thermo-cautery has failed because deep penetration of heat is essential to successful treatment. Surgical removal is apt to be incomplete, often stimulates the growth and disseminates metastases by the opening of lymphatics and blood vessels.

Chloroform, administered always by a skillful anesthetist, has been found to be the best anesthetic to use with this form of therapy. Local anesthesia, nitrose oxide, and ether are all unsuitable and the last of these especially dangerous with diathermy.

Laryngotomy as a method of approaching the larynx is not used because the knife may penetrate the tumor mass and metastases follow. Suspension laryngoscopy is used and recommended to others. A preliminary tracheotomy is necessary in all these cases.

From one thousand to fifteen hundred ma. of current are used and the average length of exposure is twenty seconds, but the time varies with the rate and extension of coagulation. Fractional coagulation is preferable.

Lessening of pain is a striking feature of the immediate after effects. The necrotic mass separates within ten days. It is too early tin the history of cases so far treated to form definite conclusions, but favorable end results are expected.

Treatment of Glandular Metastases of Carcinoma. Russell H. Boggs, M. D., Am. J. Roentgenol, February, 1922, p. 117.

SITUATION, extent and depth of disease, amount of cross-firing necessary, and the ratio between the erythema and lethal dose in malignancy are the most important factors to be considered in the treatment of metastatic glands.

A point hretofore too little considered, is that palpable enlargement of the glands of one lymphatic chain is usually accompanied by microscopic involvement of the next chain.

Metastasis and recurrence, it should also be noted, are not synonymous terms; the former is the spread of malignancy and the latter refers to a return of malignancy in the region of the primary growth.

Escaping from the primary growth into the lymphatic vessels cancer cells may lodge there and form a secondary growth, or may be carried to the lymphatic glands, where they may possibly be destroyed or they may produce a secondary growth there if not destroyed.

All of the lymphatic system adjacent to a primary growth should be rayed —this is patent from the intimate relation known to exist between carcinoma and the lymphatics. The radiologist must know the paths of dissemination, therefore.

Ewing's summation of Handley's conclusions in regard to the likely path of metastatic travel is given. This is applicable to any organ. A similar description of the drainage of mouth and throat areas is also given.

The method of treating metastatic glands varies and good results are secured by these various methods. Methods in use at the Freiburg and Erlangen clinics are discussed. The Germans state that even less than an erythema dose will destroy cancerous cells, and the author takes issue upon this point.

Radiation is thé only therapeutic measure which offers anything at all when more than one chain of lymphatics is involved, even though microscopically. The most effective method is one by which the largest amount of radiation will reach all cancerous cells with the least injury to overlying structures.

High Voltage X-ray Work. W. D. Coolidge and W. K. Kearsley, M. D., Jr. Am. J. Roentgenol, February, 1922, p. 77.

THE original paper covers some twenty-four pages of description accompanied by charts, diagrams and tabulations. The following summary by the authors is slightly abbreviated from the original.

1. A design of x-ray tube is shown which has served for experimental work up to 300,000 volts maximum.

2. This type of tube can apparently best be operated from either a high voltage transformer with mechanical rectifier and resistance control, or from a suitable source of high voltage direct current. (The x-ray output and tube behavior with other high tension systems are also discussed.)

3. An experimental interrupterless machine is described which has operated satisfactorily, even in humid weather, at voltages up to 300,000.

4. A constant-potential continuous current machine, for voltages up to 200,000 is described.

5. As measured by the penetration through ten cm. of water, two hundred kv. direct current excitation is equivalent to two hundred and thirty-five kv. (max.) of alternating current excitation. At these voltages the x-ray intensities are the same for equal milliamperage.

6. For the medical application, it looks much safer to judge of x-ray intensity and quality, from sphere gap and milliamperemeter measurements of the electrical energy put into the tube rather than from direct measurements made with an ionization chamber.

7. Even when such outwardly different high voltage sources as the transformer with mechanical rectifier on the one hand and the induction coil on the other are used the resulting radiations differ in quantity and quality by scarcely more than the experimental error, when the energy input is controlled by a standard sphere gap and a milliamperemeter.

8. The voltage at the terminals of the x-ray tube should be controlled by a voltmeter connected across the low tension side of the high voltage generator, and the low tension voltage required to produce the desired tube voltage should be frequently determined by means of a standard sphere gap connected in parallel with the tube. This calibration must be made at the exact milliamperage which is to be subsequently employed.

9. For accurate duplication of results, it is desirable that the design of the high tension source shall be such that, for a given high tension voltage, the required primary voltage will not change rapidly with the milliamperage passing through the tube.

10. For the measurement of the tube current in therapy, two milliamperemeters should always be used in series with the tube, and they should be occasionally compared with a standard meter.

11. Where an interrupterless machine with resistance control is employed and the tube filament is heated from the same source of current supply, the milliamperage should be held very constant by a suitable stabilizer, as otherwise line voltage fluctuations will cause marked fluctuations in the high tension voltage, owing to the presence of the resistance in the low tension circuit.

12. At 200,000 volts (max.), with as much as 0.2 mm. of copper filter, different "high voltage" tubes differ but little in output, the average deviation from the mean in a series of twenty tubes being only one and one-fourth per cent.

13. At 127,000 volts (max.), with as much as three mm. of aluminum filter, different "Universal" type tubes differ but little in output, the average deviation from the mean in a series of seventeen tubes being about three per cent.

14. Where no filter is used, tubes differ markedly in output, owing to differences in bulb thickness. This would be of no importance in connection with plate density in diagnostic work, in which the patient's body is interposed between the tube and plate or tube and screen; it might, however, be quite important in skin therapy with unfiltered radiation.

15. For the therapeutic application, the effect of the tungsten deposit on the bulb can apparently be neglected.

16. Bad pitting of the target appreciably reduces the efficiency of the tube in the direction of the central beam. For this reason, therapy tubes should not be used for radiographic work, in which pitting might occur.

17. Curves are given showing the distribution of x-ray intensity in different directions around the focal spot, at voltages of 127,000 and 200,000.

18. The intensity maximum does not lie in the "central beam." but from ten to twenty degrees away from this towards the heel of the target. (This is probably due in the main to the fact that the cathode ray stream does not hold to the axis of the tube, but is electrostatically deflected towards the toe of the target.)

19. In the equatorial plane (about the girdle of the tube) the intensity is essentially constant through an angle of about one hundred degrees.

20. The distribution curves for a badly pitted target are also given.

21. Absorption curves are given for copper, extending up to two hundred and nintey-eight kv. (max.) They show the attractiveness of high voltage excitation if a considerable intensity of very penetrating radiation is required.

The lowest value of the average linear absorption coefficient indicated is 2.31. This corresponds to a wavelength of 0.072 Å.

Problems in Massive Dose X-ray Therapy—Newer Methods of Application and Measurement. Edwin C. Ernst, M. D., J. Missouri S. M. A., April, 1922, p. 144.

DR. ERNST believes that eventually cancer will be treated by a blood serum. For the present combined methods must be used—surgery, the cautery, coagulation, dessication, radium and x-ray. No one man can fully master all of these and therefore selective co-operation among a group of specialists is absolutely essential.

Of all these methods radiation therapy has perhaps made the greatest advancement. The author discusses the physics of this subject somewhat in detail for the sake of the general practitioner, and a portion of his summary is here quoted:

"Each individual deep therapy transformer should be standardized and periodically the potential should be checked by means of sphere gap measurements Filtration material should be tested carefully by photographic methods to exclude variations in quality or quantity. The high tension meters should likewise be frequently calibrated.

"In addition to the above standardization of technique and consideration of mechanical details, extreme caution should at all times be exercised in the administration of these intensive radiation by further careful attention to the individual characteristics of both the patient and the local lesion."

The writer states that as nearly as is possible with available apparatus he has sought to duplitize the techniques applied by Kroenig, Friedrich, Dessauer, and Schoenburg. Minimum exposure was three hundred milliampere minutes over a single area, the maximum dose was seven hundred milliampere minutes. Three ports of entry were used and the following factors were kept constant: *Filtration*, one-half mm. copper and the equivalent of eleven mm. of aluminum and glass. *Focal distance* limited to thirty-five centimeters. *Voltage* readings (sphere gap measurements) 140,000 volts. *Current* passing through Coolidge tube, five ma.

Time was the only factor not remaining constant. The entire dose he extends over a period of from three to five successive days.

Minimum exposure produces very faint tanning; maximum exposure is very severe and applicable only to inoperable breast pathology. The danger from toxicity resultant upon continuous treatment over six hours must be avoided. Selection and distribution of these massive doses must be according to individual need. Previous treatments must be taken into account.

A graduated standard technique with a known and tested apparatus, frequently corrected meter readings, non-variable and measured potential, and *carefully selected and tested metal filters* are absolutely requisite to this intensive therapy.

These massive doses have been employed by the author for a period of only five months, and therefore definite final conclusions cannot as yet be drawn but such results as have been obtained are promising. Palliation in malignancy of the stomach is especially discussed. Uterine malignancy has responded more favorably than any other type.

Roentgenotherapy in Tuberculosis. Fritz Hilpert. M. D., *Erlangen Clinic*. Muenchen. med. Wchnschn., March 10, 1922, p. 348

THE internist may no longer ignore the fact that roentgenotherapy has attained a place in the treatment of tuberculous lesions.

Much has been written upon this subject and many varying techniques are advocated by different roentgenologists. These are all discussed in the original paper. For a long time only small doses were employed until Wintz appeared upon the scene with his technique for this lesion; the dosage used by him is equivalent to fifty to sixty per cent of the skin-unit-dose (HED) advocated by him.

It must be clearly understood that this dosage does not apply to the treat-

ment of pulmonary tuberculosis. In contrast to this dosage the one advocated by Bachmeister is very small, and Stephen has advanced the theory that there is one common dosage (ten per cent HED) applicable to all tuberculous lesions.

The rather widespread idea that there is a common dosage has undoubtedly brought with it some little confusion and whether there is a common dosage for tuberculosis is a question that must be settled. The author, for his part, has arrived at these conclusions:

There is no common dosage for tuberculosis. The dosage established by Wintz, fifty to sixty per cent of the HED, and employed in tuberculosis of the peritoneum and tuberculosis of the lymphatic glands, the author of this paper considers to be a little too high. He advocates a dosage of forty to fifty per cent HED instead. Stephan's dosage of ten per cent HED in the treatment of pulmonary tuberculosis he believes has only questionable value.

The author uses, for the above mentioned lesion, six per cent HED at the beginning of treatment, gradually increasing it up to fifteen to twenty per cent. Around twenty-five per cent is the best dosage in combating tuberculosis of the larynx and much larger doses must be employed for lupus and for tuberculosis of the skin—at least eight per cent HED. These dosages are to be delivered to the focus of the lesion; if the lesion is a superficial one, one port of entry is usually employed, in the deeper lesions two or more are necessary.

The author states that his experience with this form of therapy leads him to the conviction that the roentgen rays are a useful adjuvant in treating tuberculosis of the peritoneum, the lymphatic glands, also pulmonary tuberculosis, tuberculosis of the larynx and of the skin.

Post-Operative Mastoid Treatment with X-ray. Charles Goosmann, M. D., J. Radiol., June, 1922.

THE writer, knowing that patients with acute mastoiditis often experience relief after the slight exposure incident to taking plates, decided to use postoperative roentgen treatment with mastoid cases not properly healing.

The postoperative interval among cases so treated by him has varied from twenty-five days to five years. The results are such that he now advocates the use of roentgenotherapy in such cases.

Roentgen Ray Anthropometry of the Skull. A. J. Pacini, M. D., J. Radiol., June, 1922.

THIS thesis, awarded first place in the Leonard Research Prize Contest, is here published in part as the first of a series to appear upon alternating months in the Journal.

There being no consciously propounded and scientifically defended system of roentgen ray anthropometry anywhere extant, this subject was chosen by Dr. Pacini for an original thesis. It is thought that the research here recounted may serve, not only the medical profession, but the arts and other sciences as well. "It does not appear that roentgenology has heretofore been propounded as the basis of an anthropometric system, useful alike in anthropologic medicine and in medical anthropology; and this thesis presents a propounded and defended system of roentgen ray anthropometry useful to serve both the anthropologist and the physician in the common objective of the study of 'human evolution, development, transmission, classifications, effects and tendencies of man's bodily and functional differences'."

The thesis is divided into four parts. Part I critically considers the technique of the investigation. Part II discusses the principles common to physical anthropology and to roentgen ray anthropometry and this is followed by the records of measures of anthropometric entities, such as diameters, angles and indices in a series of skulls. Part III includes the measures derived by the system of roentgen ray anthropometry elaborated, and contact prints of the skulls from which these measures were derived. Part IV is a bibliography, carefully compiled and of attested accuracy, having reference only to such articles as have a direct bearing upon the various topics in anthropometry presented in this thesis.

Radium and Roentgen Ray Therapy in Malignancy—Indications, Contra-Indications, Limitations and Recent Developments. Arthur U. Desjardins, M. D., J. Radiol., June, 1922.

IN this paper the inverse square law is first emphasized, since radiation is absolutely dominated by this law, and means of overcoming the handicaps imposed by this law are given. Filtration is discussed here also.

Indications, contra-indications for radium and roentgen ray therapy, combined treatment, metastasis, pre-operative and post-operative treatment form the subjects for the body of this treatise.

Recent developments in technique are much more briefly discussed and summarized.

Duodenal Bulb Deformity in Relation to Symptoms and the Chemistry of the Gastric Juice. A. W. Crane, M. D., J. Radiol., June, 1922.

DUODENAL bulb deformity outranks every other x-ray sign of duodenal ulcer. Cole's serial method gives roentgen diagnosis the advantage over surgical exploration.

Accessory roentgen signs are relatively indecisive, yet bulb deformity, alone, is not sufficient for diagnosis. The history of the case and the chemistry of the gastric juice must be considered and the author tolerates no objection to this view. Carman and Holzknecht are cited in support of stomach analysis.

In the author's laboratory the last five years the stomach contents of about one thousand cases have been obtained by the Rehfuss method and most carefully and completely examined. Four types of curves were found, and though these bear a closer relation to symptoms than to bulb deformity, they are yet significant.

Four hundred and thirteen of the thousand cases showed a hyperacidity; one hundred and nineteen showed achylia. Diagnosis was: Duodenal ulcer, one hundred and twenty-six; gastric ulcer, twenty-eight; duodenal cancer, one.

These cases were studied by both x-ray and clinical methods. The fine art of taking histories is emphasized, too often they yield nothing of importance because not skillfully taken. In the absence of hyperacidity the presence of a history suggestive of ulcer, in a case of achylia, would lead the author to a search for other pathology. Diverticula, chronic appendicitis and cholecystitis may lead to a mistaken diagnosis.

Only twenty-five of these one hundred and twenty-six ulcer cases were operated. Operation was advised in many more, but prompt and satisfactory recovery under alkaline treatment as practiced by Sippey led to elimination of operation in many of these. Ulcer was found in nineteen of the twenty-five operated. In two cases, at the patient's request, the duodenum was not explored; in the remaining four cases three showed a persistent bulb deformity.

A sound diagnosis must be based upon ulcer history, hyperacidity, and bulb deformity. The use of the clinical record before x-ray diagnosis is urged.

Cancer of the Lip Treated by Radiation or Combined with Electro-Coagulation and Surgical Procedure. George E. Pfahler, M. D., J. Radiol, June, 1922.

ANY fissure or crust on the lip which lasts longer than a month should lead to the suspicion of malignancy and

this is where the general practitioner has a great responsibility. Early local destruction by electro-coagulation, followed by thorough radiation, should cure practically all such cases. Suitable selection must be made for electro-coagulation, and poor technique with this or any form of treatment will usually lead to failure. No matter what other form of treatment is employed, radiation must be used in all cases of cancer of the lip, care being taken to ray the lymphatics which drain the diseased area.

Recurrent carcinoma gives much less satisfactory results. Metastatic lymph nodes should be treated by surface radiation followed by implantation of radium or excision. The patient must be kept under observation for several years after final treatment.

Study of Hilus Pneumonias by Serial Radiographic Examination. L. R. Sante, M. D., J. Radiol., June, 1922.

SERIAL radiographic examinations of cases of atypical pneumonia, taken during the recent epidemic of influenza, revealed interesting data bearing upon cause, mode of invasion and prognosis.

Some of these types had never before been encountered by the roentgenologist, and to determine whether they were peculiar to the epidemic serial radiographic examinations were since then made of all atypical cases coming under observation.

The different types of consolidation encountered in this work are considered separately and notation made as to age in each case. One type, an acute inflammatory type, and another which had milder constitutional symptoms and was more protracted in its course, gave quite similar radiographic characteristics. The tuberculous type is given considerable space in the consideration.

The author sums up the pertinent points thus: "In short, a pneumonic process of inflammatory type may involve the hilus region in either children or adults. Such involvement may terminate in complete and rapid restoration to normal in either case. Where a previous tuberculous process is present in the hilus, the inflammatory reaction may be sufficient to activate the old quiescent lesion. In children the less confined character of a tuberculous lesion produces a more diffuse reaction, while in adults the heavy barrier of fibrous tissue about the lymphatics and the caseous lymph glands offers a better field for local disintegration and cavity formation."

Some Clinical Observations of Radium Therapy. C. W. Hanford, M. D., Med. Rec., April, 1922, p. 173.

AT first only advanced and inoperable cases of malignancy came to the radium therapist, but the remarkable results with these cases soon opened a much wider door. John G. Clark and other gynecologists are now quite definite upon the point of the more than potential supremacy of radium and the x-ray.

The author grants the distinct place of surgery in malignancy, but protests against blind adherence to it, and insists that when it is used it should be accompanied by radium and x-ray.

For the benefit of those in general practice, not yet fully informed in regard to radiotherapy, the effect of radiation upon malignant tissues, and tumor absorption, are discussed.

The question of whether radium is a cure is squarely and honestly dealt with.

In breast surgery the author does not agree with Beck that radium by the open wound method should be used, for he does not believe that the theory that toxins are stored up is by any means proved as yet.

In rectal carcinoma he believes that a colostomy should be done first, followed by radium application to the cancerous lesion, and this followed a week later by extirpation of the growth, this to be followed by postoperative treatment. No satisfactory end result can be promised. The palliative effects of radium can be relied upon in these cases, however.

In carcinoma of the bladder malignant papillomata are cured by radium. The writer uses six hundred mg. hours per each two square centimeters of involved tissue, gauze being placed between the tube and the area radiated. True infiltrating carcinoma of the bladder is rarely, if ever, anything but hopeless with any means of treatment.

In esophageal cancer radium has accomplished some clinical cures and gives palliation. With more perfect technique and more exact dosage there will come greater success in dealing with this lesion. From his experience the author believes that twelve hundred mg. hours (held in place twenty-four hours by carrier) is the proper dosage and that smaller doses should not be used.

In hyperthyroidism radium has proven itself to have decided merit. Some cases, of course, must go to the surgeon. One twenty-four hour treatment with needles imbedded to give a dose of 1440 mg. hours is usually sufficient.

In carcinoma of the prostate favorable results have followed radium therapy. This is combined with surgery, the dosage being one thousand mg. hours for each lobe.

Radium is a specific in uterine hemorrhage. Interstitial fibroids may be reduced by its use, but the hard nodular subserous fibroid calls for operation.

The closing paragraph is a discussion of Levin's findings regarding the effect of radium upon lymphocytes.

Radium Therapy. By Frank Edward Simpson, M. D., professor of Dermatology, Chicago, Polyclinic; Adjunct Clinical Professor of Dermatology, Northwestern Unioversity Medical School; Attending Dermatologist to Mercy Hospital, Alexian Brothers Hospital, Henrotin Hospital, etc.; Former President American Radium Society; Former Vice-Chairman, Section of Dermatology and Syphilology, American Medical Association; Director of The Frank Edward Simpson Radium Institute. Octavo, 391 pp. 166 original engravings. 1922. C. V. Mosby Company, St. Louis. Cloth, $7.00.

THE technique of the preparation of radium emanation for therapeutic use and the method of measuring its gamma ray activity is given about the same space occupied by the first three chapters combined. The Debierne-Duane apparatus is illustrated and described in detail. A definition of "radioactive substance" is next given and the physics of the alpha, beta, and gamma rays are briefly discussed.

Absorption and filtration of the rays is given a brief chapter, followed by twenty pages upon the absorption of gamma rays in water. Here the author gives the results of his own experimental work on the absorption of gamma rays; the main problem studied was whether the scattering of the gamma rays causes any change in the intensity of the rays at various depths below the surface of the skin. Charts, diagrams, and tables illustrate the wealth of detail given in this chapter.

In the discussion of the physical and chemical effects of radium rays a paragraph each is given to the ionization of gases, penetration of opaque matter, production of heat, emission of light, phosphorescence and fluorescence, photographic action, and the coloration of various substances; other chemical effects are mentioned.

A thirty page chapter on the biologic effects of radium rays reviews the results secured by various investigators and this experimentation all has a direct bearing upon the therapeutic uses of radium. The effects upon bacteria, seeds, and plants, lower forms of animal life, various tissues of higher forms of animal life, hemapoietic organs, various

glands, the blood, nervous system, and upon the eye are here included and are described macroscopically and histologically. The lethal and stimulative effects of the rays upon malignant cells are discussed and immunity, with respect to malignant growths, is the subject of the last two pages of this chapter, and is followed by a short chapter upon the reactions from surface radiation and from intratumoral radiation.

Therapeutic apparatus, dosage and technique are then taken up; the first and last of these topics being described with the aid of illustrations. The discussion of the last topic is limited, mainly, to that of the different principles involved.

The subject of dosage occupies thirty pages of expository and descriptive text, seven of these, approximately, give space to tabulations, the value of which may be illustrated by the following verbatim excerpt: "While the number of 'milligram hours' may be easily found by multiplying the number of mg. used by the number of hours of exposure, the problem is not so simple when one wishes to compute the number of 'millicurie hours,' on account of the decay of the emanation, which loses approximately sixteen per cent of its activity each twenty-four hours. It is of importance, therefore, to determine the amount of emanation with which it is necessary to start a given interval (treatment) in order to have a given mean value during that interval. This is shown in Table XXIX." There follows this the time of application in hours, from one hour to forty-eight, with the corresponding number of millicuries necessary to start with in order to have a mean value of one hundred.

The second half of the book deals with the therapeutic uses of radium and has a chapter each upon the following subjects: Radiation in Gynecological Surgery; Radiation in Dermatology; Radiation in Optholmology, Otology, Rhinology and Laryngology; Radium in Diseases of the Ductless Glands; Radium in Internal Medicine. In this last chapter the topics discussed are the following: the administration and elimination of radium, physiologic effects of radium, morphologic changes caused in tissues by radium, therapeutic indications. In all these chapters the pathology, technique and dosage for each case are described.

Approximately eighty plates, many of which are double, and thirty illustrations of lesions, including some histological studies help to drive home the subject matter of the text and are excellent reproductions.

The closing chapter is upon professional injuries due to radium, and takes up the local and constitutional effects of radium and suggests various protective measures and devices.

The bibliography consists of fifty-eight pages of eight point type covering the French, German, and English literature upon this subject from 1903 on, and is, of course, of great value in itself.

Standardization of Dosage Factors. H. J. Ullmann, M. D., Santa Barbara, Calif. J. Radiol., May, 1922.

IN the average laboratory there is a great deal of carelessness and inaccuracy apparent, which is dealt with specifically in this paper. The writer suggests that much of the variation in effects found by different workers, who supposedly are using equal dosage factors, is due to actual variations in the factors themselves, to inaccurate measurements and differences in nomenclature.

The physical factors of voltage, filtering, volume of current, time, distance, and size of area treated are discussed and the question of measurement is taken up for each of these separately.

He concludes: (1) The methods commonly used in practice to measure the physical factors of an x-ray dose are grossly inaccurate. (2) Much or most of the work being done on the biological effect of radiation is either valueless or must be repeated with properly controlled physical measurements before the differing results can be correlated. This applies even more strongly to clinical measurements. (3) Many variations in effects reported by different observers would probably cease to exist if their physical factors, within reasonable limits, were the same. (4) When roentgenologists realize these facts and adopt uniform methods of measuring and recording, the records and observations will increase in value in proportion to their uniformity, and, when sufficient accurate data has accumulated it will be found that many of the discrepancies reported by the different workers will cease to exist.

ERRATUM

IN the May issue of the Journal, page 207, the abstract "The Possible Relation of Secretion to Cancer," contains a typographical error, in that the word "secretion" appears throughout the abstract instead of "secretin."

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC. REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912

of Journal of Radiology, published monthly at Omaha, Nebraska, for April, 1922.

STATE OF NEBRASKA } ss.
COUNTY OF DOUGLAS }

Before me, a Notary Public in and for the State and County aforesaid, personally appeared Herbert S. Tyler, who, having been duly sworn according to law, deposes and says that he is the Business Manager of the Journal of Radiology, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to-wit:

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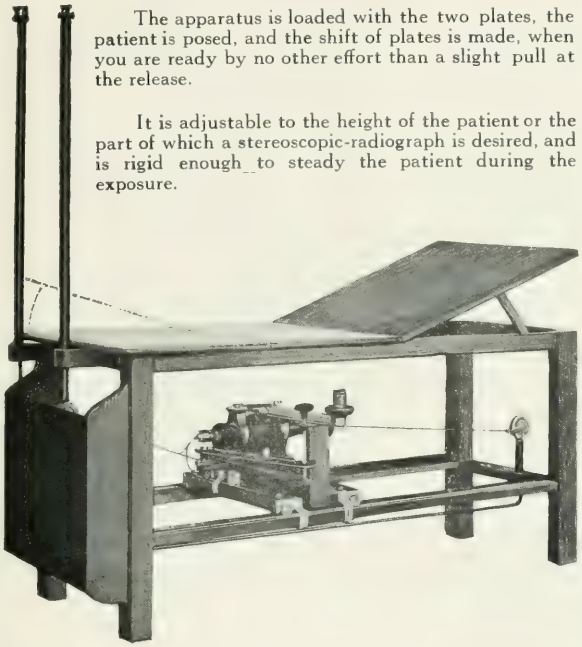

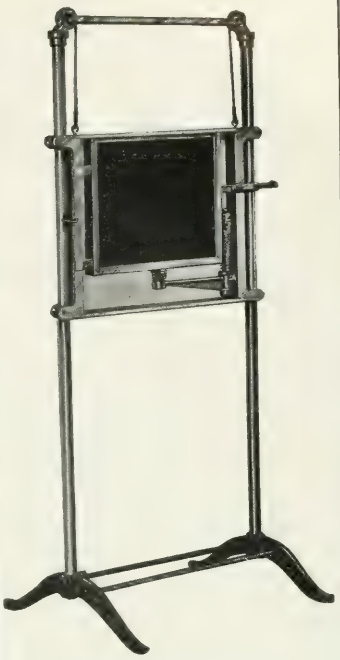

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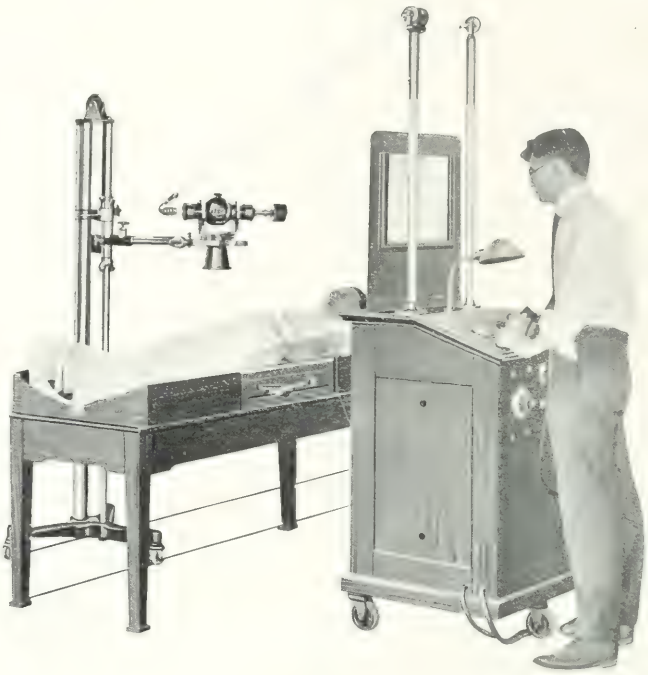

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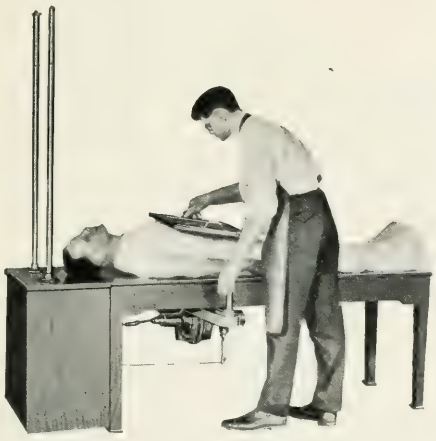

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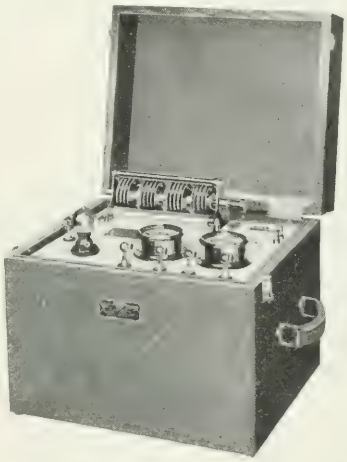

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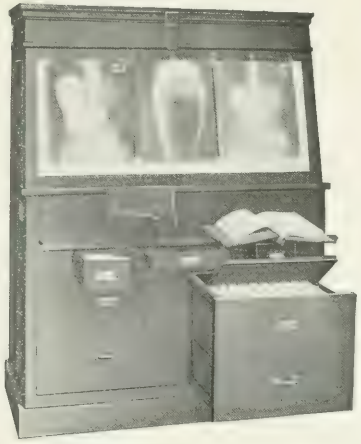

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NO, FOR IF THIS IS TRUE YOU ARE DEFEATING THE ORIGINAL PURPOSE.

IF YOU ARE INTERESTED IN IMPROVING YOUR WORK YOU WANT THE BEST APPLIANCES TO ACCOMPLISH RESULTS.

WHAT SCREEN?

IF YOU HAVE NEVER USED SCREENS YOUR GUIDE IS, WHAT YOU HAVE OBSERVED IN OTHER LABORATORIES, AND THE NAME YOU HAVE ALWAYS ASSOCIATED WITH SCREENS—"PATTERSON".

WHY "PATTERSON"?

OVER TEN YEARS OF EXPERIENCE AND RESEARCH.
THOUSANDS OF SATISFIED USERS.

WHAT SCREEN DO WE RECOMMEND AND WHY?

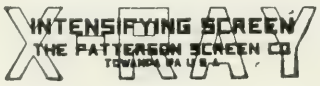
THE PATTERSON "CLEANABLE" INTENSIFYING SCREEN.

QUALITY AND SERVICE.

LAST YEAR YOU BOUGHT "PATTERSON" SCREENS CHIEFLY ON ACCOUNT OF QUALITY; FOR THE MORTALITY OF SCREENS, REGARDLESS OF THE MAKE, WAS HIGH.

THIS YEAR YOU CAN BUY THE "PATTERSON CLEANABLE" AND GET NOT ONLY QUALITY BUT SERVICE.

ASK YOUR DEALER



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THE PATTERSON SCREEN COMPANY

TOWANDA, PENNSYLVANIA, U. S. A.

INTENSIFYING X-RAY SCREENS

Equal to any intensifying screen for plate or film work on the market.
Your money refunded if not entirely satisfactory or as represented.

SIZE	SINGLE WASHABLE	SINGLE CLEANABLE	DOUBLE WASHABLE	DOUBLE CLEANABLE
8 x 10	$ 8.00	$ 7.50	$16.00	$15.00
10 x 12	11.00	10·00	22.00	20.00
11 x 14	16.00	15.00	32.00	30.00
14 x 17	21.50	20.00	42.00	40.00

Immediate Delivery on Cleanable. One month on Washable.
Terms: C. O. D.

NATIONAL X-RAY SCREEN CO.
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FOR ALL RADIOGRAPHIC and FLUOROSCOPIC WORK

THE STANDARD X-Ray Transformer, "Type D," is ideal for the office of the general practitioner. With it all radiographic and fluoroscopic work may be done efficiently, accurately, and as speedily as desired.

Furnished with remote control—at a price which will prove interesting to those who desire convenience, power and compactness in their X-Ray equipment.

67½ kilo-volt capacity (any line voltage)

STANDARD X-RAY COMPANY

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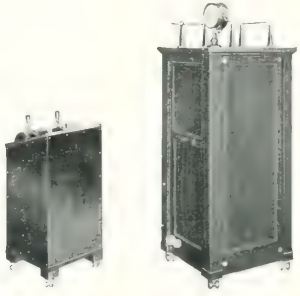

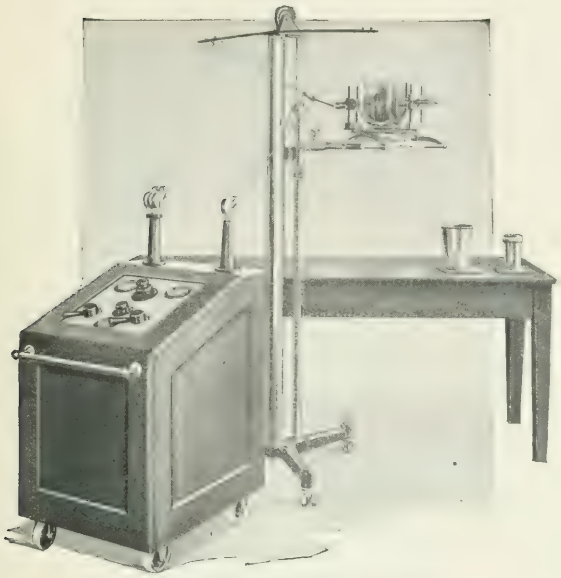

The Complete Intermediate Equipment

The Intermediate X-Ray Unit

WITH THE

ROTARY WAVE SELECTOR

operating in the

SECONDARY CIRCUIT

delivers a unidirectional current from the secondary terminals of the transformer directly to the tube

FOR THERAPY—1-5 ma., 4-9 inch gap
FOR RADIOGRAPHY—1-40 ma.,3-6 in. gap
FOR ALL FLUOROSCOPY

Cabinet Dimensions
31 x 26 x 22 inches

The only machine providing sufficient capacity for RADIOTHERAPY at the BEDSIDE

THE ROTARY WAVE SELECTOR
operates in the
SECONDARY CIRCUIT

With the ROTARY WAVE SELECTOR in the primary circuit the Intermediate would be an impossibility

HOWEVER, with the ROTARY WAVE SELECTOR in the secondary, the Intermediate Unit generates x-radiation of more intense photographic effect, saves time, tubes, space and money.

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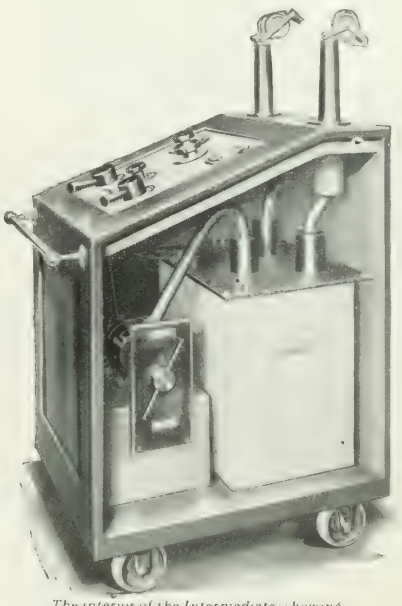
Distributors in all Principal Cities



The interior of the Intermediate, showing the Rotary Wave Selector

"Best By Test --- Regardless of Price"

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This Screen is being exhibited at the various X-Ray Conventions with phenomenal success. We are daily receiving letters from Roentgenologists who have purchased it, expressing their pleasure and satisfaction, all of them sending re-orders,—*the best test of satisfaction.*

It is used and endorsed by the leading X-Ray men of this country. It is 25% *faster* than any other screen on the market today, is absolutely grainless, and possesses a range of detail (blacker blacks to whiter whites) unequalled, which makes the reading of your negative a pleasure! These advantages, together with the low prices at which we offer it, are worthy of your consideration. Ask for further information, and save 50% in your present high screen costs! The non-washable screen is furnished with our protective covering, which renders it immune to dust, spots and scratches, and prolongs its life indefinitely.

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(Non-washable Screen, with our protective covering)
Every screen tested and guaranteed perfect.

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We will be pleased to send circular describing a new Fluoroscopic Screen, the result of latest French research. This screen gives a pure white, concentrated light with minimum of power,combining the advantages of *distance* with *minimum of exposure* to the radiologist—two factors of great importance. Especially adapted for gastro-intestinal work with heavy patients where deep, rapid penetration is essential. Can be furnished in any desired size, at a big saving in cost.

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Sole U. S. Distributors of French Screens

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A Reliable X-Ray Vehicle

The Original

Possesses advantages in efficiency, expediency, and palatability.

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GEHLER FOLIES have stood the acid test for over 14 years
GEHLER FOLIES are used by known Roentgenologists all over the world
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GEHLER FOLIES are absolutely grainless
GEHLER FOLIES have a very hard and glossy surface, assuring long life
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NOT HIGHER IN PRICE — BUT HIGHEST IN QUALITY

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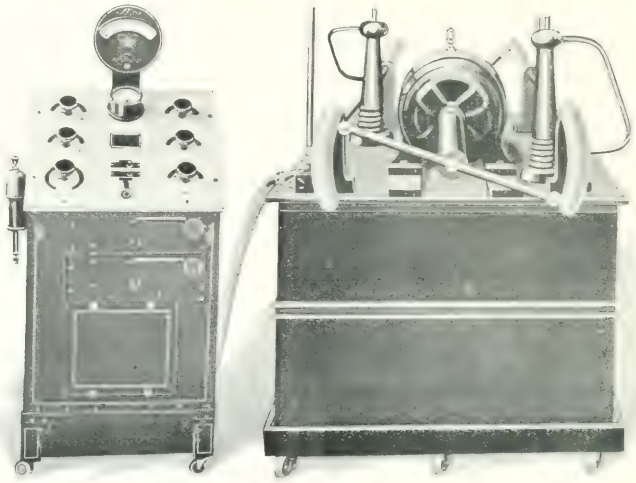
Mail us your Cassettes: we will mount correctly new Screens: Free of Charge

Kelley-Koett Deep Therapy Apparatus



Coronaless rectifying system as well as many other salient features.
Capacity 280,000 peak volts, equivalent to a 20 inch gap.

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The new Kelley-Koett motor-drive fluoroscopic table is a part of the DupleXray. From the vertical to the trendelenburg-automatically. The DupleXray is complete for all your radiography and fluoroscopy. Quantity production permits the remarkable price. You are familiar with Kelley-Koett and Engeln x-ray products. Write for our special catalogue describing the DupleXray

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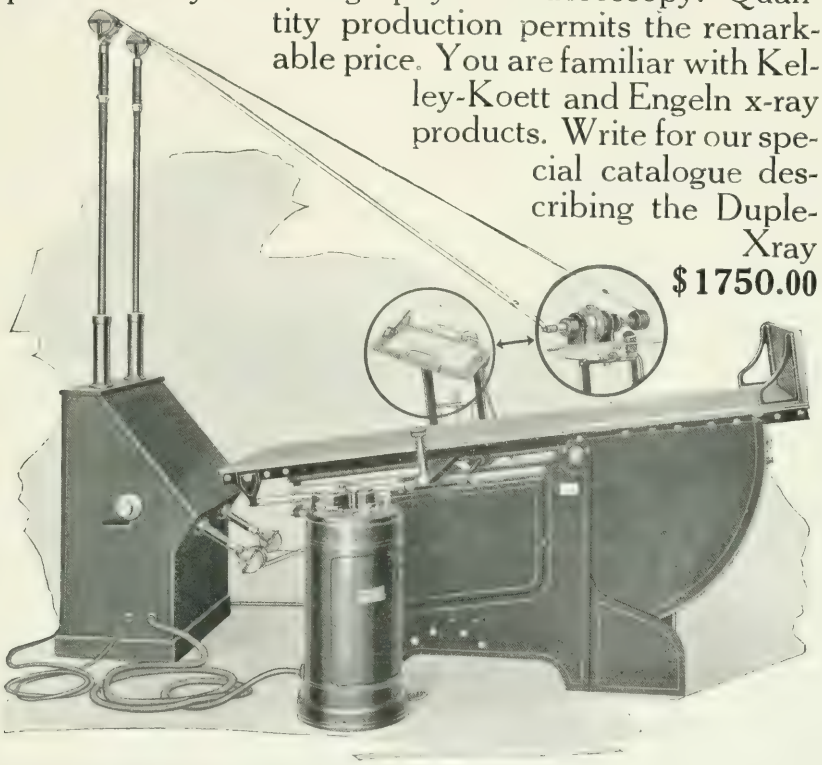

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New classes are started on the first of each month.

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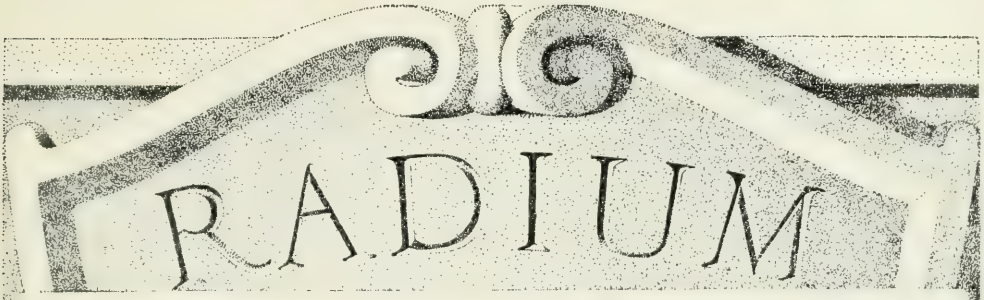
Applications for reservations should be placed as early as possible.



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It gives us pleasure to announce to physicians interested in radium that the Insurance Company of North America will write radium insurance at two per cent a year. For a loss under this policy the insurance company is liable for 75%.

When the great advances in radium insurance rates went into effect, we immediately took steps to obtain for physicians an acceptable policy at a reasonable premium. This announcement is the result.

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United States Radium Corporation

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Factories: Orange, N. J. Mines: Colorado

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For the X-Ray Laboratory

A supply of electric energy;

A means of transforming a current of low tension into one of high tension;

A transformer;

An x-ray bulb.

Of those necessary these are among the first facilities you consider. For second consideration there are your accessories.

Every Roentgenologist and laboratory that has purchased x-ray accessories through Picker Service knows that it can be depended upon for standard and guaranteed supplies at lower prices.

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The SWEETBRIAR SCREEN when first placed on the market set a unique standard—*absolute freedom from grain*. This quality, together with its hard, glossy, washable surface, and its contact-producing flexibility, at once made it a recognized competitor against the best of Intensifying Screens.

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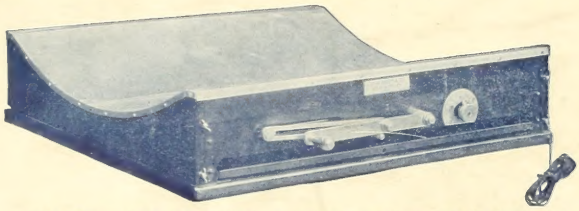
BRADY'S POTTER BUCKY DIAPHRAGM



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YOU CANNOT GET A BETTER BUCKY AT ANY PRICE AND NO X-RAY LABORATORY IS COMPLETE WITHOUT ONE

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PARAGON SCREENS A very fine product in every way. We do not hesitate recommending the PARAGONS for all ORDINARY RADIOGRAPHIC work. The price is especially low, being APPROXIMATELY ONE-HALF that of other standard makes. Cash discount from this low list, 5% for payment in ten days.

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STOP COLD WEATHER TROUBLES

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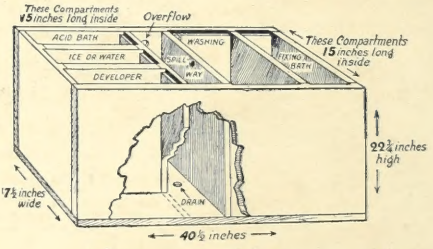

	4-Comp.	5-Comp.	6-Comp.
F. O. B. Chicago or Brooklyn	$45.00	$52.00	$58.50
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ENAMEL TANKS—3-compartment style, 8x10, $22.50—11x14 size, $27.00.

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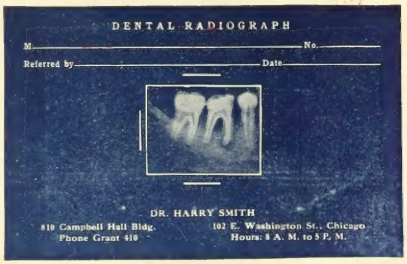

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We have many types of film mounts, including the green, gray and black cardboard with a celluloid window and all-celluloid mounts. We are offering same at lower prices and liberal discounts. Our new "SUNNYSIDE" MOUNT is guaranteed to remain flat. We also have a new cardboard mount without celluloid to hold the new Eastman Translucent Film with frosted back.

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